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Hanging by a thread

SPIDER COMMUNITIES IN RAINFOREST FRAGMENTS AND SHADE-COFFEE PLANTATIONS IN THE ANAMALAI HILLS, WESTERN GHATS, INDIA

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About the author

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Cover photographs

Left. *Argiope aemula*

Right *Gasteracantha dalyi*. (Photo credits: Robin D' Rozario).

Summary

Studies on the effects of tropical rainforest fragmentation and disturbance have often focussed on plants and vertebrates such as birds and mammals and seldom on invertebrates, despite the latter being among the most biologically diverse groups in these ecosystems. Spiders are one such group of invertebrate predators that are known to be sensitive indicators of environmental change in tropical ecosystems. The present study assesses the spider community structure and responses to rainforest fragmentation and degradation and conversion to shade-coffee plantations in the Anamalai hills, southern Western Ghats, India. Ten rainforest fragments ranging in size from 11 ha to 2,600 ha under varying levels of degradation within the Indira Gandhi Wildlife Sanctuary and private lands of the Valparai plateau, and two shade-coffee plantation sites were sampled for spiders using visual searches along time-constrained belt transects between January and May 2005. Within a total sampled area of 5.76 ha, 4,565 individual spiders (4,300 detections) belonging to 156 morphospecies within 21 families and 8 functional groups were recorded. The estimated total number of understorey spider species in the study area was 192 (± 5.15 SD) species, representing around 13% of the total number of spider species so far described from India. Overall spider density, species richness, and species density showed no trend in relation to fragment area across all sites. Specific comparisons among relatively undisturbed sites indicated however that high altitude sites had fewer species than mid-altitude sites and fragments had fewer species than relatively larger continuous forest sites. In contrast to the lack of trend in overall species richness and abundance, species composition changed substantially in relation to habitat alteration and altitude. Cluster analysis of Bray-Curtis similarities among sites in spider species composition revealed four distinct clusters: high altitude relatively undisturbed sites, mid-altitude relatively undisturbed sites, mid-altitude disturbed sites, and shade-coffee plantation sites. Spider species, such as *Psechrus torvus* and *Tylorida culta*, that contributed significantly to the dissimilarity between undisturbed and disturbed rainforest sites, and rainforest and shade-coffee sites were identified that serve as useful indicators of habitat alteration.

Introduction

The loss and fragmentation of tropical rainforest which holds a major proportion of the world's biological diversity remains a crucial global conservation problem (Whitmore 1997). Studies looking at the effects of tropical forest fragmentation and disturbance have tended to focus on vertebrate groups particularly birds and mammals, and plants (Turner 1996). There has been a paucity of research on invertebrates in this regard despite the fact that they make up a significant portion of the animal diversity in tropical rainforests (Klein 1989). This is surprising because given their short life cycles, high abundances and their sensitivity to environmental change, invertebrates are a useful group to use to understand the effects of processes such as habitat fragmentation (Jansen 1997, Marc et al. 1999, Miyashita et al. 1998).

Spiders are one such group of invertebrate predators in tropical ecosystems that are known to be sensitive indicators of environmental change (Jansen 1997, New 1999, Norris 1999, Hodge and Vink 2000). A hectare of tropical forest is known to have about 300 to 800 species of spiders (Coddington et al. 1991) often occurring in high abundance. Spiders also have an added advantage of being conspicuous and amenable to techniques of observation that are relatively cheap, easily deployable, and replicable, making them a group suitable for statistical comparisons, and monitoring of sites or habitats. Furthermore, their predatory habits, short life cycles, varied dispersal systems, and sensitivity to change in vegetation structure make spiders good ecological indicators (Jocqué et al. 2005, Wise 1993). India has 59 of the 110 spider families and 1,442 of the 39,000 species known worldwide (Siliwal et al. 2005, Platnick, 2005). More species undoubtedly await discovery, with estimates of global spider species diversity being around 80,000 species (Cushing 2001). Documenting and understanding spider communities assumes greater significance in the context of current rates of loss and degradation of tropical forest, which is known to have detrimental effects on many invertebrate groups (Pik et al 2002).

The present study was carried out in a rainforest-plantation landscape in the Anamalai hills in the southern Western Ghats. The Western Ghats has been identified as a global biodiversity hotspot (Myers et al. 2000) for its biodiversity value and for the high levels of human disturbance (Nair 1991, Menon and Bawa 1997). The once-pristine tropical rainforests of the Western Ghats, home to rare and endemic species of plants and animals, are today relatively small pockets of forests lying within a mosaic of human habitation and plantations (Raman and Mudappa 2003). Research on birds, amphibians, reptiles, and small carnivores in rainforest fragments in the Anamalai hills has shown that significant populations of these animals survive here despite large-scale disturbance and habitat alteration, although their long-term survival may depend on maintenance or restoration of habitat quality and connectivity (Umapathy and Kumar 2000, Kumar et al. 2002, Raman and Mudappa 2003, Mudappa and Raman *in press*). However, there has been little ecological research on invertebrates in the Western Ghats especially in relation to habitat disturbance or fragmentation (Gadagkar et al. 1990,

Basu 1997, Babu 2000, Badrinarayanan 2001). Past studies on spiders have also been few and mainly involve inventories (Patil and Raghavendra 2003, Patel 2003).

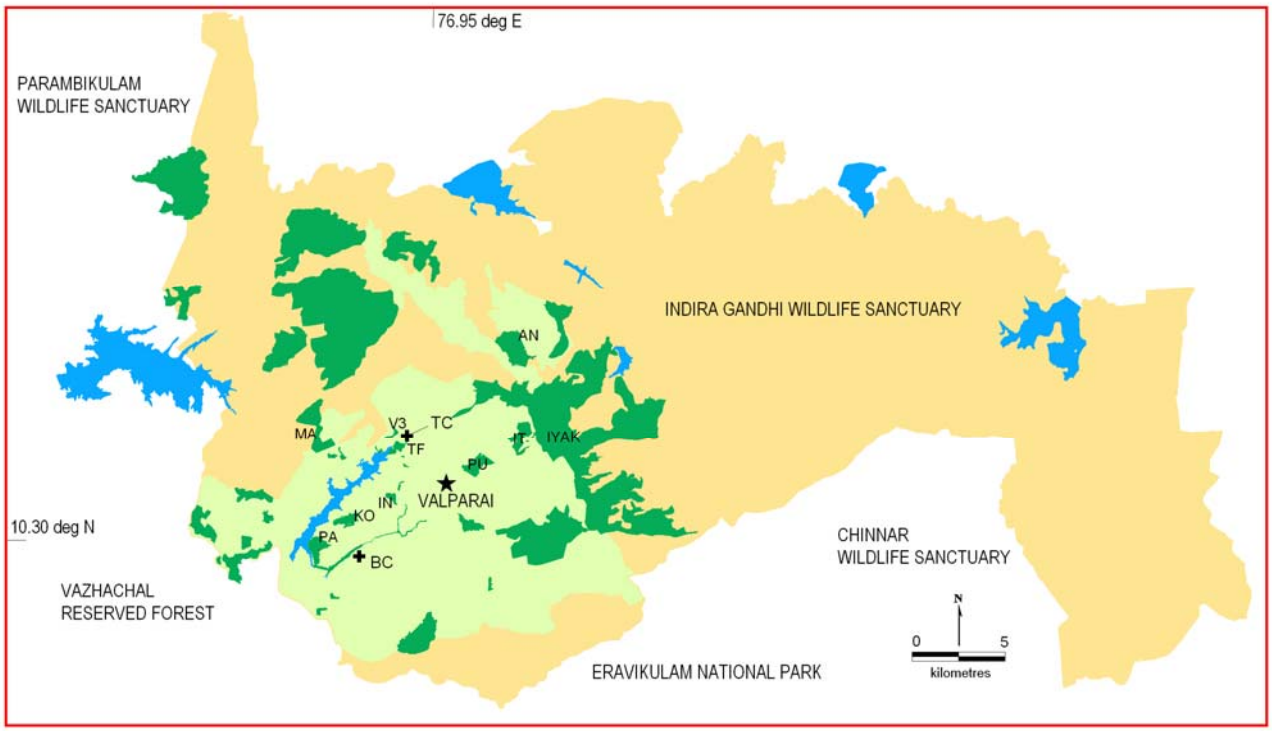
The present study explores patterns of spider species diversity and community structure of understorey spiders and effects of rainforest fragmentation and plantations on this group in the southern Western Ghats. The specific objectives were:

1. To study community structure and patterns of diversity of spiders in disturbed rainforest fragments and shade-coffee plantations in comparison with relatively undisturbed rainforests in the Anamalai Hills of the Western Ghats.
2. To establish a sampling and monitoring protocol for spiders, and identify possible indicator species or groups to use as biotic indicators of the quality of a habitat.

Study Area and Study Sites

The study was carried out in the Valparai plateau and the Indira Gandhi wildlife sanctuary of the Anamalai Hills (10º 12´ N to 10º 35´N and 76º 49´ E to 77º 24´ E) in the southern Western Ghats between January and May 2005. The Valparai plateau spanning an elevation of 900 m to 1,500 m above sea level contains over 220 km² of tea, coffee, and cardamom plantations surrounded by the Indira Gandhi Wildlife Sanctuary (958 km^2) in Tamil Nadu state and other protected areas and reserved forests in Kerala state (Fig. 1). The natural vegetation of this region has been classified as

Figure 1. Map of the Valparai plateau (light green) in relation to surrounding protected areas showing rainforest fragments (dark green) and reservoirs (blue). Fragments and plantation sites (+) sampled for spiders are indicated; site codes as in Table 1.



mid-elevation tropical wet evergreen rainforest of the *Cullenia exarillata-Mesua ferrea-Palaquium ellipticum* type (Pascal 1988). The mean annual rainfall is about 3,500 mm, mostly received during the southwest monsoon (June – September) with moderate amounts also received during the northeast monsoon (October – December), with more dry weather during January to May. At least 35 rainforest fragments occur within the private plantations in the Valparai Plateau and these have been identified as important for conservation (Mudappa and Raman *in press*) since they contain significant proportions of the native fauna besides being important for landscape-level connectivity between fragments.

Ten rainforest fragments and two shade-coffee plantation sites ranging in area from 11 ha to 2,600 ha and within an altitudinal range of 750 – 1,400 m were chosen for the study (Table 1). The rainforest fragments included three relatively undisturbed ones within the Indira Gandhi wildlife sanctuary (IYAK, MA, AN), and seven smaller privately-owned fragments within the plantations of different companies. The privately-owned fragments included four rainforest sites under varying levels of degradation (TF, V3, IT, PA). In addition, there were three highly disturbed rainforest sites (IN, PU, KO) that also contained portions of abandoned coffee or cardamom plantations with a mixed canopy of native rainforest trees and planted exotic trees such as *Maesopsis emenii* and *Spathodea campanulata* (Muthuramkumar et al. 2006, Mudappa and Raman *in press*). Two of the privately-owned highly disturbed fragments are now being protected as part of a restoration programme; IN since 2000 and IT since 2003(Mudappa and Raman *in press*). All rainforest fragments are subject to some level of disturbances such as fuel wood collection, cattle grazing, and occasional tree cutting. The two shade-coffee plantation sites differed in their vegetation structure and landscape features. TC

Table 1. Description of the rainforest fragments and coffee plantation sites sampled during the study.

Fragment	Code	Area (ha)	Altitude (m)	Ownership	Sampling effort	
					km	min
Iyerpadi-Akkamalai	IYAK	2600	1380	FD	3.09	1219
Manamboli	MA	200	785	FD	2.06	851
Andiparai	AN	185	1270	FD	2.04	893
Iyerpadi Top	IT	100	1400	P	2.24	906
Puthuthottam	PU	92	1120	P	3.00	894
Pannimade	PA	88	1032	P	2.39	915
Korangumudi	KO	56	995	P	2.53	908
Tata Finley	TF	32.6	980	P	2.20	900
Injipara	IN	19.1	992	P	2.34	900
Varattuparai 1-3	V3	11	975	P	2.26	915
BBTC Coffee	BC	83.8	1000	P	2.51	868
Tata Coffee	TC	100	980	P	2.12	903

FD- Forest Department; P – Private

bordered a forest fragment (TF), had much taller and older coffee plants, and a mixed overstorey of native rainforest and exotic trees, whereas BC connected to a degraded fragment along the Sholayar river, had younger and shorter plants, and a monoculture of *Eucalyptus* as shade trees.

Methods

Spider sampling

Visual searches were carried out for spiders along belt transects of 2 m width and a maximum searching height of 1.6 m. The transects were walked as straight as possible and existing paths and trails in the fragments were used most often, and in the coffee sites the rows between the coffee plants were used. Each belt transect was more or less of 180 minutes duration, excluding time for identification and collection of natural history information (refer Table 1). The distance covered in each site varied depending on the density of shrubs and weeds which affected ease of movement within a site. All observations were made by one observer (VK) assisted by a field assistant who paced the transect length. From an earlier study, this method was found to be relatively efficient and was well suited for spider observations and collection of natural history information (Kapoor, submitted). All vegetation substrates within this space such as tree bark, foliage, twigs, and branches were carefully scanned. Leaf litter was not sifted, but spiders displaced from the litter while walking were included in the sample. Spiders encountered were identified to morphospecies and natural history information such as type of web (structure, size), substrate and posture was recorded. Five belt transects were surveyed in each site at approximately monthly intervals between January and May 2005, except in the largest site (IYAK) where seven transects were surveyed, and in MA and AN where four transects were surveyed. Repeat surveys within a site were carried out over the same general area within each fragment. Time of sampling varied between 07:15 and 14:30 h but was restricted to days without rain and with dry and sunny weather.

Taxonomy

Spiders were identified to family and species using existing identification keys wherever possible (Pocock 1900, Levi and Levi 1968, Tikader 1980, 1982, 1987, Tikader and Malhotra 1980, Kaston 1978, Cushing 2001, Koh 2000). Due to the non-availability of identification keys for many families and field guides of spiders for the study area and the time required for conventional taxonomic work, a morphospecies approach was used to classify spiders. This approach has been found to be effective for poorly known and species-rich taxa such as spiders and other invertebrates (Oliver and Beattie 1996, Krell 2004). New or unfamiliar spiders were collected live in plastic vials and brought back to the field station for detailed observation on the same day. If a new (possibly rare) morphospecies with just one or two individuals was detected, then collection was avoided and as much description as was possible was noted in the field itself. Details of body parts, such as pattern of eye arrangement of live

spiders or occasionally of fresh spider specimens preserved for less than 24 hrs, were observed using a simple microscope (10-20X) or a compound microscope (Lawrence and Mayo, 100X). The identification features were noted and sketched for each taxon. Spiders were also classified into eight functional groups based on hunting method and web type from the literature (Levi and Levi 1968, Kaston 1978, Opell and Eberhard 1984, Toti *et al*. 2000) and observations in the field.

Analysis

Spider community variables of primary interest were species richness (number of species in a standardized sample size of individuals) and species density (number of species per unit area) as defined in Gotelli and Colwell (2001). The area covered by each transect varied and hence, for each transect, the number of spiders detected on each transect was divided by the area of the transect and multiplied by 100 to obtain spider species density per 100 m². The values were averaged across the replicates and the standard deviation values calculated for each site sampled. The computer software ECOSIM (Gotelli & Entsminger 2001) was used to calculate rarefaction species richness for a standardized sample of 200 individuals. To estimate the total number of species in each site (hereafter called estimated species richness), the Jackknife 1 estimator was used on the species abundance data using the computer program EstimateS (Colwell and Coddington 1994, Colwell 2000). Relationships among spider community variables and between spider variables and fragment area were explored using scatterplots and their statistical significance assessed using Spearman's rank-order correlation coefficients (Zar 1999).

A dissimilarity matrix of sites in spider community composition was calculated using the Bray-Curtis index (Krebs 1989) implemented in the program PRIMER (Clarke and Gorley 2001). The dissimilarity matrix was used as input for cluster analysis and non-metric multidimensional scaling (NMDS) to examine and visually represent similarities between sites in spider community composition.

Further comparisons of dissimilarity in composition were made between groups of sites identified as follows: (1) high *versus* mid-altitude sites—the two relatively undisturbed fragments of high altitude (IYAK, AN, > 1,250 m) were compared to two relatively undisturbed rainforest fragments at a mid-altitude (MA, PA; 750 – 1,100 m); (2) disturbed fragments (IN, KO, PU) *versus* relatively undisturbed fragments (MA, IYAK) fragments; and (3) coffee plantations (TC, BC) *versus* rainforest fragments at a comparable altitude (MA, PA). The SIMPER (similarity percentage) procedure in the program PRIMER was used to calculate the contribution of each species to the average dissimilarity between the above three groups of sites. This was done by first computing the average Bray-Curtis dissimilarity ($\overline{\delta}_{jk}$) between all pairs of inter group samples (*j* and *k*, with *j* in the first group and *k* in the second group). The percentage contribution of each species (i) to the Bray-Curtis dissimilarity between the samples is computed as $\delta_{jk}(i) = 100 \cdot \left| y_{ij} - y_{ik} \right| \Big/ \sum_{i=1}^{S} \left(y_{ik} + y_{ik} \right)$;

where S is the total number of species. This is averaged across all pairs of inter-group samples j and k to obtain the average contribution $\overline{\delta}_i$ of species i to the overall dissimilarity between the groups (Clarke and Warwick 1994).

Results

A total of 4565 spiders (4300 detections) was recorded within a total sampled area of 5.757 hectares across the 10 forest fragments and two coffee plantation sites. These comprised of 156 identified morphospecies belonging to 21 families and 8 designated functional groups (Appendix 1). An additional six species were recorded during opportunistic observations (Appendix 2). A description of the spider morphospecies is provided in Appendix 3.

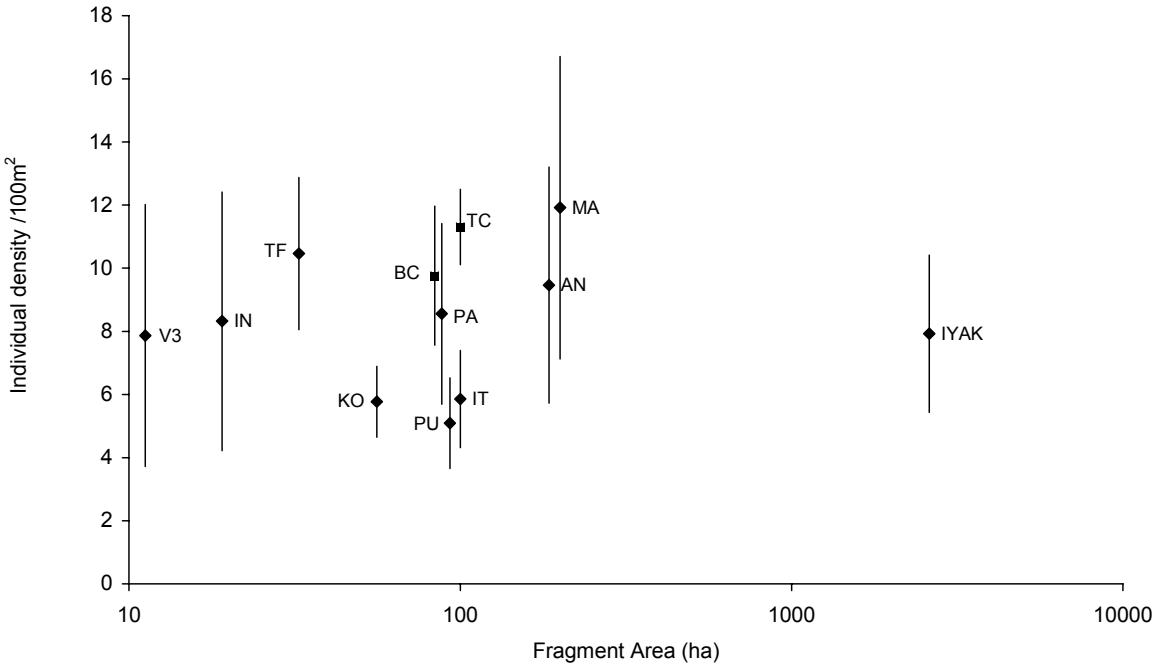
Species richness and abundance

Spider density and species richness showed no discernible trend in relation to fragment area ranging from 11 to 2600 ha (density: r_S = -0.18, n = 12, p = 0.58 and species richness: r_S = -0.23, n = 12, p = 0.47). Across sites, average spider density ranged between 5 and 12 individuals/100 m² (Fig. 2a), while average species density ranged between 2 and 3.6 species/100 m² (Fig. 2b). The highest species density was found in a coffee plantation site (TC). There was a weak but significant positive relationship between individual and species densities (r_S = 0.61, n = 12, $p < 0.05$).

The smallest fragment (11 ha) Varattuparai 1-3 (V3) had the highest rarefaction species richness (Fig. 3). The estimated species richness (Jackknife 1) also did not show any discernible trends with area (r_S = 0.10, n = 12, p = 0.75, Fig. 3). However the estimated species richness was highest in Manamboli (MA), a relatively undisturbed fragment within the sanctuary closely followed by a coffee plantation site (TC, Fig. 3). Interestingly the other two large protected fragments at higher elevations (IYAK, AN) had relatively low values of estimated species richness and rarefaction richness. The estimated species richness for the entire study area based on the pooled data across all sites was 192.4 (± 5.15 SD) species.

The two coffee sites showed significant difference in all measures of richness. Tata Coffee (TC) when compared to BBTC Coffee (BC), despite similar area and spider densities (Mann-Whitney U = 7, n = 5,5, p = 0.251) had significantly higher species density (Mann-Whitney U = 2, n = 5,5, p = 0.028, Fig. 2b), rarefaction richness (z = -2.11, $p < 0.05$), and estimated species richness (z = -5.05, $p < 0.05$, Fig. 3).

Figure 2. Effects of rainforest fragmentation on spider community structure in the Anamalai hills, India: (a) Individual density and (b) species density in relation to fragment area. Vertical bars represent 1 SD about the mean. Site codes as in Table 1. Shade-coffee plantation sites are designated by filled squares.



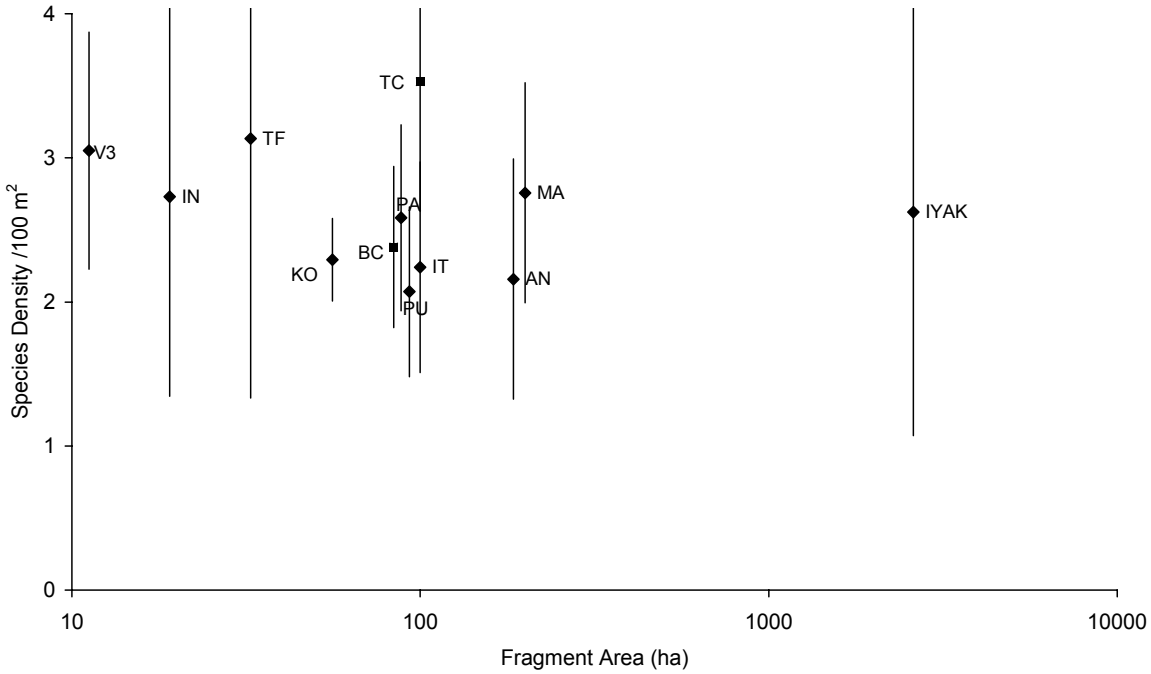
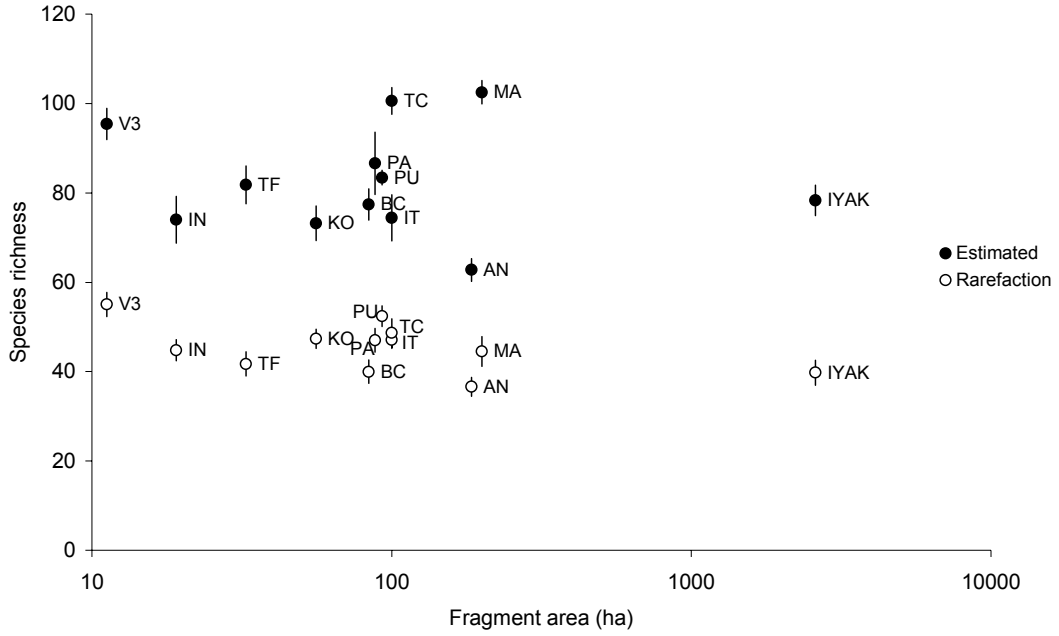


Figure 3. Spider species richness in relation to fragment area in the Anamalai hills, Western Ghats, India. Shade-coffee plantation sites are designated by squares. Open symbols represent rarefaction spider species richness (number of species/200 individuals) and filled symbols represent first order Jackknife estimator of species richness. Vertical bars indicate 1 SD about the mean. Site codes as in Table 1.



Spider Community Composition

The dendrogram of the sites constructed using the Bray-Curtis dissimilarity index in spider species composition seemed to form four distinct clusters (Fig. 4). One cluster comprised of the two large relatively undisturbed fragments within the sanctuary (IYAK, AN) that were also at a higher altitude compared to the other study sites (Table 1). The three fragments (IN, KO, PU) which were originally coffee or cardamom plantations along with Iyerpadi Top (IT) formed a cluster, while the relatively disturbed fragments with primary rainforest vegetation (V3, TF, PA, MA) formed a separate cluster. The two coffee sites (TC, BC) also formed a distinct cluster.

The Bray-Curtis dissimilarity matrix was also used as the input for a non-metric multidimensional scaling ordination of the sites (Fig. 5, stress = 0.06). This showed finer differences between the groups obtained from the cluster analysis. For example, the mid-altitude primary rainforest fragments (MA, PA, TF, V3) which formed a cluster in the dendrogram was seen to consist of two separate groups in the MDS. Manamboli (MA) a large fragment within the sanctuary appeared to be relatively separated from the other three fragments that are on private land (PA, TF, V3). The x-axis on the MDS output can be interpreted as an axis of increasing development of primary rainforest vegetation while the y-axis can be seen as one of increasing altitude.

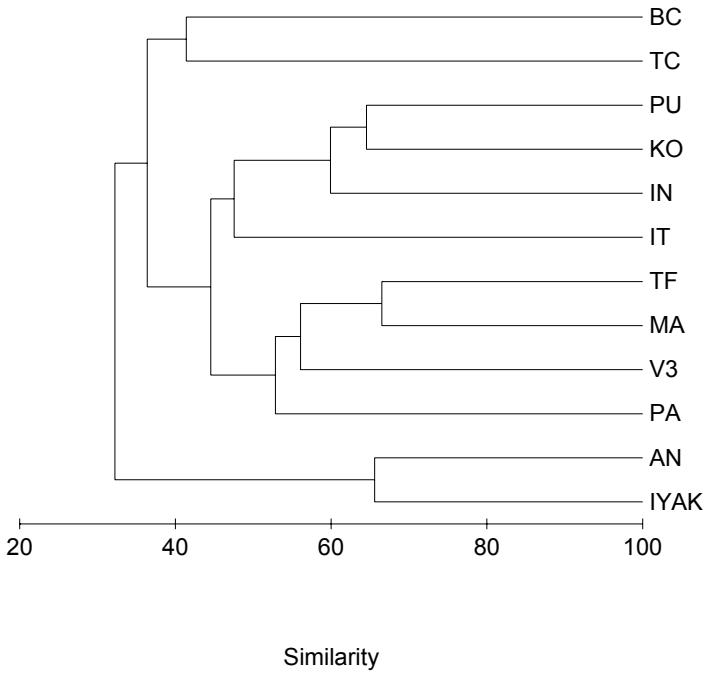


Figure 4. Variation in spider community composition across sites: dendrogram constructed using group average clustering of Bray-Curtis similarity values. Site codes as in Table 1.

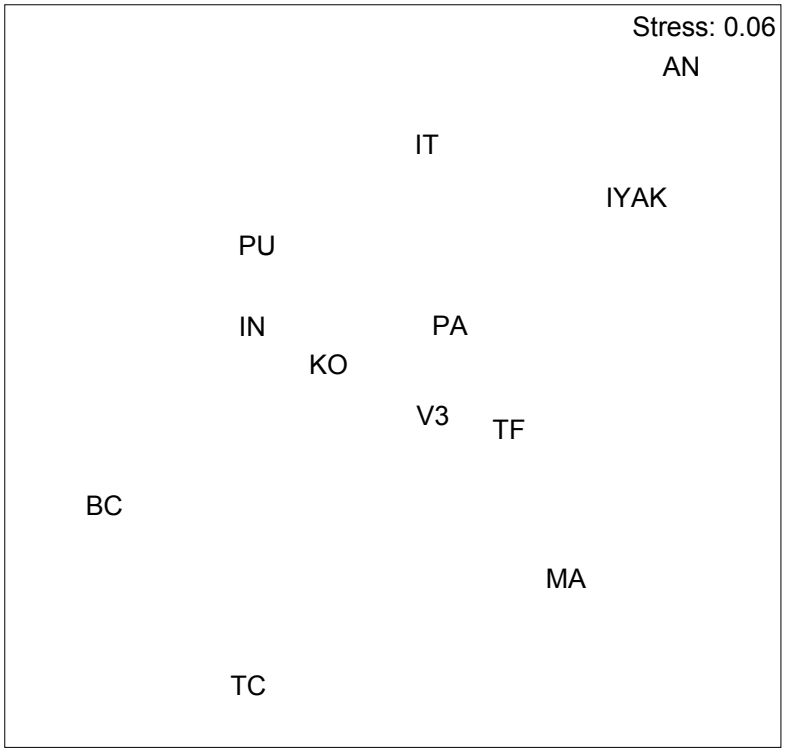


Figure 5. Variation in spider community composition across sites: non-metric multidimensional scaling ordination of sites based on Bray-Curtis similarities in spider species composition. Site codes as in Table 1.

Further comparisons of dissimilarity in composition were made to identify the species contributing most to the difference between groups of sites. The average dissimilarity between high altitude and mid-altitude sites was 60%, between disturbed and relatively undisturbed sites was 58%, and between coffee plantations and rainforest fragments was 64.7%. The 10 species contributing most to the difference between groups of sites contributed 58.4%, 52.8% and 52.1% of the dissimilarity between high and mid-altitude sites, between disturbed and undisturbed sites, and between coffee and rainforest fragments, respectively (Table 2).

Table 2. The top ten species contributing to the dissimilarity between high and mid-altitude, undisturbed and disturbed, and shade-coffee and forest fragment sites.

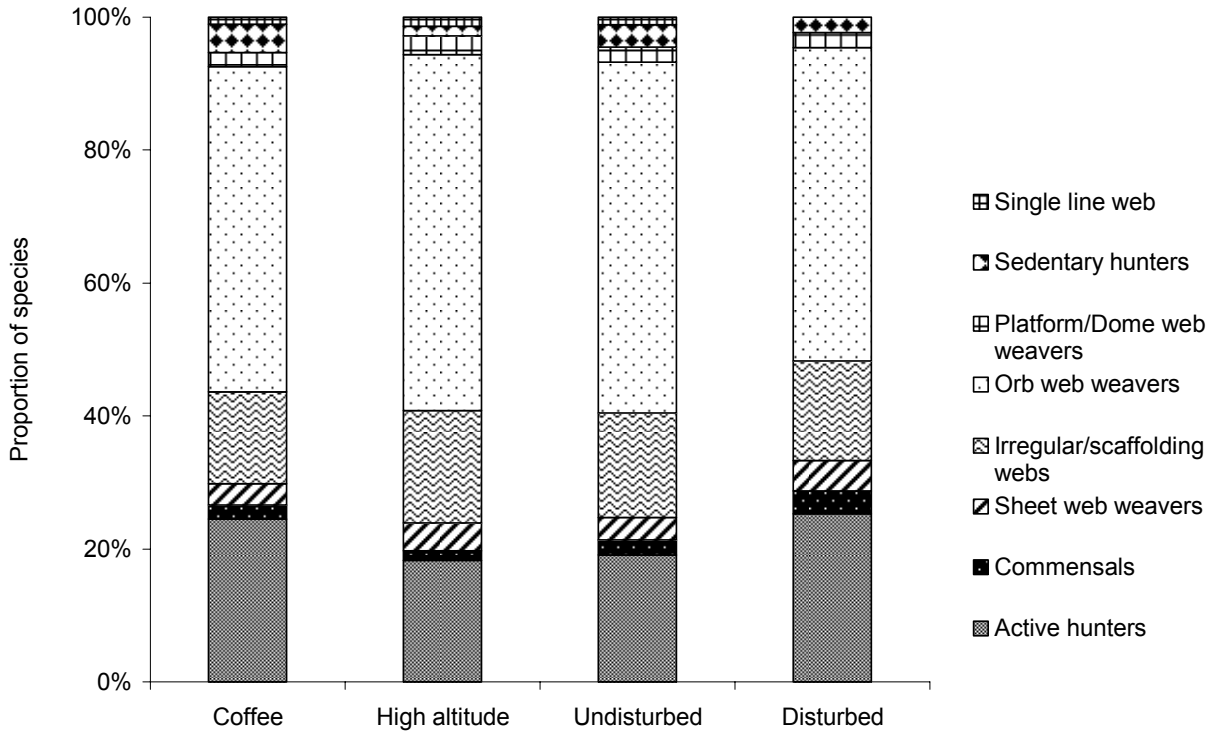
Factor	Species	Average abundance		Contribution % (Cumulative %)
I. Altitude		High	Mid	
	Linyphia sp. (black)	75.5	25	10.26
	Smeringopus sp.	82.5	33	10.06
	Psechrus torvus	33	60.5	7.41
	Gasteracantha hasseltii	0.5	27.5	5.39
	Leucauge sp.(decorata?)	3.5	27.5	4.8 (37.9)
	Crossopriza sp.	25.5	4.5	4.56
	Eriophora sp.	22	0.5	4.31
	Psechrus sp.	1	23	4.3
	Steatoda sp.	20.5	1.5	3.83
	Theridid sp. 6 (cream)	11.5	23	3.46 (58.4)
II. Disturbance		Undisturbed	Disturbed	
	Psechrus torvus	70.5	0	13.51
	Smeringopus sp.	51	0	9.79
	Linyphia sp. (black)	42	27	4.99
	Crossopriza sp.	24	1.67	4.61
	Psechrus sp.	22	0	4.21 (37.1)
	Gasteracantha hasseltii	19	0	3.64
	Leucauge sp.(decorata?)	18.5	28.67	3.3
	Nephila like sp. (cone web)	4	19.33	2.97
	Tylorida culta	9	24.33	2.96
	Uloborus sp. 3 (orange)	15	0	2.87 (52.9)
III. Habitat		Coffee	Forest	
	Psechrus torvus	0.5	63.5	10.86
	Leucauge sp.(decorata?)	78.5	27.5	8.93
	Nephila like sp. (cone web)	52.5	14.5	6.73
	Smeringopus sp.	3	34	5.43
	Linyphia sp. (black)	10.5	41	5.3 (37.3)
	Dictyna sp. (leaf web)	24.5	9.5	3.57
	Nephila pilipes	21	1.5	3.5
	Theridid sp. 6 (cream)	20	24.5	2.89
	Opadometa fastigata	15	1	2.45
	Cyclosa neilensis	16	5.5	2.44 (52.1)

This analysis identified species characteristic of each group of sites. For example, a species belonging to the family Psechridae, *Psechrus torvus*, was almost absent in the coffee (TC, BC) and the disturbed rainforest fragments (IN, KO, PU) but was present in fairly high abundance in the relatively undisturbed rainforest fragments (MA, PA, IYAK). Two species belonging to the family Araneidae, *Tylorida culta* and *Leucauge sp.* (*decorata*?), which build typical orb webs, were found more often in the disturbed and coffee plantation sites (Table 2).

Functional group composition

To verify whether these clusters of sites differed at the coarser level of functional groups, the proportional contribution of each functional group to the species richness of a cluster of sites was calculated (Fig. 6). The groups of sites did not show any significant difference in the proportional contribution of the different functional groups to the species richness ($\chi^2 = 5.73$, $df = 21$, $p = 0.999$).

Figure 6. Variation in spider functional group composition across different categories of sites in the Anamalai hills, Western Ghats, India.



Discussion

Spider species richness and abundance in relation to area and altitude

The results of the study clearly indicated that fragment area did not have a significant effect on the overall spider species richness, species density, and individual densities over a span of fragment sizes from 11 ha to 2,600 ha. The similar lack of trend shown by different indices and estimators of community structure indicates that this result is robust. A possible sampling bias could have arisen from better detectability in areas such as the more open coffee sites that had better light penetration and visibility compared to rainforest fragments. However, highly disturbed fragments such as KO, PU, and IT that were also relatively open had low spider densities, indicating that detection-related sampling biases may not be involved. The use of a relatively narrow strip (1 m on either side of the transect line) also helped minimise bias.

The findings of the present study are contrary to some earlier studies on the effects of forest fragmentation on invertbrates and spiders. In urban forest fragments of Japan, smaller fragments had fewer web-building spider species and lower densities of individuals and there existed a significant positive correlation between fragment size and species density (Miyashita et al. 1998). In central Amazonia, with decreasing fragment area dung and carrion beetle species composition changed significantly and species richness in isolated fragments was lower than in continuous forest (Klein 1989).

In the intensive study area of the Anamalai hills, earlier studies on butterflies (Babu 2000) and birds (Raman 2001) showed similar lack of trend with fragment area on species richness and abundance. As relatively good natural history information were available on the different species in these studies, the authors were able to categorise the community into rainforest and open-forest species among birds and into rainforest and light-loving species among the butterflies. When species characteristic of rainforests were separated from species not naturally found in undisturbed rainforests, these studies also documented increase in species richness with fragment area for rainforest species and a converse decreasing trend for the atypical species. Such a categorisation was not possible for spiders in this study because the documentation of the natural history of South Asian spiders has been poor, with virtually no information on spiders found in the Western Ghats rainforests. The present study is a first step towards collecting this information and this is elaborated in the latter part of the discussion.

Comparisons between sites reveal some patterns in species richness variation. The relatively undisturbed sites at high altitudes (AN, IYAK) had lower rarefaction and estimated species richness than relatively undisturbed mid-altitude sites (PA, MA, Table 1). Within these two pairs of sites, the smaller fragment had lower mean rarefaction and estimated species richness. A similar decrease in richness with elevation has been documented in studies on birds and butterflies in the same area (Babu 2000, Raman 2001), and a study on plant communities showed that tree basal area was

negatively correlated with altitude (Muthuramkumar et al. 2006). Another notable aspect is that the site with the highest rarefaction richness (V3) is different from the site with the highest estimated species richness (MA). This is possible because the latter is a mid-altitude relatively undisturbed site with a number of rare species detected just once or twice, leading to a high Jackknife estimate.

Differences between the shade-coffee plantation sites

TC and BC are both organically grown coffee plantations with roughly the same area (Table 1, BC is a certified organic plantation). Although spider density did not differ significantly between the two sites, estimated species richness and rarefaction measures were higher in TC than in BC. One possible reason is that in TC native rainforest tree species such as *Palaquium ellipticum*, *Cullenia exarillata* and *Mesua ferrea* along with exotics such as *Erythrina indica* and *Maesopsis eminii* were used as shade trees for their coffee shrubs and from qualitative observations this formed a better shade than in BC, which had a monoculture of exotic *Eucalyptus sp.* as canopy. A study on the impact of land use change on litter ant and beetle communities in a coffee dominated landscape in the northern Western Ghats (Badrinarayanan 2001) found that beetle species richness and abundance were higher in coffee estates with diverse shade as compared to those with monoculture shade. Interestingly, ant species richness under both systems of shade were similar but under monoculture shade a few species dominated in abundance. A second influencing factor for the differences between TC and BC could be the fact that TC adjoins two rainforest fragments (TF,V3), whereas BC had a relatively poor connectivity being surrounded by tea plantations and only a small patch of riverine vegetation adjoining it. The influence of adjoining rainforest patches for shade-coffee plantations has been shown for bird communities in the same study area (Raman 2006). This study showed that plantations with a high connectivity to rainforest fragments had higher rainforest bird species richness compared to plantations with a low connectivity to rainforest fragments or to a primary rainforest source pool. For example although TC and BC were most similar to each other in spider species composition (Fig. 4), the effects of proximity were evidenced by some species like *Psechrus sp.* and *Smeringopus sp*. often recorded in the TF site also occurring in the TC site in lower abundances (Appendix 1). These species were absent from the BC site. For reasons not yet understood, debris orb weavers of the genus *Cyclosa,* family Araneidae, were found in high abundance in the BC site compared to all other sampled sites. Another reason for the differences in the two coffee sites (from qualitative observations) could be that the coffee plants in the TC site were much taller than the BC coffee plants and hence niche availability and volume of vegetation available to spiders could have been higher.

Spider species composition and the importance of vegetation structure

The clustering of sites based on the dissimilarity index seemed to roughly separate the sites into four groups. The groups corresponded to shade-coffee plantation sites, the high altitude relatively undisturbed sites, the mid-altitude relatively undisturbed sites with primary rainforest vegetation, and

the mid-altitude highly disturbed sites. A similar pattern of site clustering has been reported in the community composition of other taxa like birds, butterflies, and plants in the study area (Babu 2000, Raman 2001, Muthuramkumar et al. 2006). A number of studies have documented the importance of vegetation structure on various animal taxa. For spiders, the physiognomy or physical structure of the environment influences the habitat preferences of species and ultimately on the spider community composition (Uetz 1979). Turnbull (1973) found that most webs have specific attachment and space requirements and these structural features necessary for web building may also limit the number of spiders present in a habitat. Microclimatic conditions are also known to influence web site selection (Turnbull 1973) and different species with varying humidity and temperature preferences may be limited to those parts of the habitat which offer a microclimate within the range of their physiological tolerances (Riechert et al. 1973).

Webb (1989) while looking at the invertebrate fauna on fragmented heathlands in UK found a decrease in the richness of spiders with diminishing structural diversity of habitats. An examination of the four groups of sites which formed clusters did show differences in their vegetation structural diversity (Mudappa 2001, Muthuramkumar et al. 2006). Though this study did not attempt to quantify habitat characteristics, it will be interesting to relate habitat characteristics and structure, especially of the herbaceous and shrub layer of vegetation (since this study was restricted to this layer of vegetation), to spider species composition. Other variables which would be affected as a result of changes in vegetation structure are microclimatic conditions, availability of prey, competition with other predators (Riechert et al. 1973) and exposure of webs to wind (Opell and Eberhard 1984) all of which are known to influence spider communities.

Functional groups and indicator species

Spiders as a group seem to possess many attributes generally required for organisms to serve as good ecological indicators—they are diverse and abundant, easily sampled, functionally significant, and are known to interact with their biotic and abiotic environment in ways that reflect ecological changes (Wise 1993, Andersen 1997, Churchill 1997). Most spider families differ in their primary foraging mode (Kaston 1978) and this has facilitated their classification into broad functional groups (Coddington et al. 1991, Toti et al. 2000). Studies on ants have shown that a combination of the use of certain indicator taxa with the functional group approach has been useful to provide valuable support to promote this group as bioindicators of ecological change (Anderson 1997, King et al. 1998). The use of certain spider families as indicator taxa has also been proposed and has been found to be a good surrogate for species richness especially when used to rank sites according to taxa richness or to set aside sites for conservation (Cardoso et al. 2004, Jocque et al. 2005). In this study, there was no significant difference in the proportional contribution of the functional groups in the different groups of sites. A caveat is that the strata sampled in this study were narrow and a broader coverage of the habitat may yield different results. As natural history and ecological information on spider species is

collected and documented, data at lower and finer taxonomic levels can be used as successfully demonstrated for some species (Riechert et al. 1973).

The serious lack of ecological and taxonomic understanding of Indian spiders hinders their use as indicators of habitat disturbance in India. This lack of understanding can severely compromise the interpretation of results from monitoring, given the need to separate environmental impacts from background variability of the spiders' natural responses (Marc et al. 1999). A first step to identifying indicators, would be to study the responses of spider communities to disturbance. It is evident from this study that although community structure attributes such as species richness and abundance show little change, spider species composition shows significant changes in relation to habitat alteration. Although the community composition does index change, monitoring can be facilitated if one or a few species can be identified that also reliably respond to habitat alteration. One such species found during this study, *Psechrus torvus* of the family Psechridae, was found in high abundances in relatively undisturbed rainforest habitats and was completely absent from the highly disturbed sites and shade-coffee plantations. From field observations, this species was noted to build its large sheet web against the base, buttresses or bark concavities of trees or against rocks on the ground and the web typically radiates outwards. One end of this sheet web has a funnel like retreat into which the spider takes refuge when disturbed. The complete absence of *P. torvus* from the highly disturbed and altered sites, including the shade-coffee plantations, could be weeding of undergrowth for plantation activities, disturbance to understorey vegetation, or the scarcity of large rocks and boulders in these sites. *P. torvus* persisted in relatively disturbed sites TF and V3 as these were remnants of rainforest vegetation though under pressure from fuel wood removal. *P. torvus* can be a useful indicator due to its specialized niche requirement, stable taxonomy, and the ease of observation and sampling because of their large and conspicuous webs.

Tylorida culta, *Nephila*-like *sp*. (cone web) and *Leucauge sp.* (*decorata*?), all belonging to the family Tetragnathidae, seem to respond positively to habitat disturbance by occurring in higher abundances in the highly disturbed and shade-coffee plantation sites. These species also occurred in very low abundances in the high altitude relatively undisturbed sites (AN, IYAK). These orb weaver species often aggregated in open patches under large canopy openings with weed proliferation (V. Kapoor, *personal observation*).

Studies have shown that changes in invertebrate communities may also indicate underlying changes in ecological processes. For instance, the effects of fragmentation on bees leads to a decline in flower pollination in smaller fragments (Powell and Powell 1987) and decreasing species richness of dung and carrion beetles results in a reduction in dung decomposition rates (Klein 1989).Thus changes in spider communities may reflect ecological impacts at the lower trophic level and across relatively small spatial scales (Churchill 1997). For restoration efforts, where the aim is to recreate the original vegetation as well as bring back ecological processes to as near a pre-disturbance state as possible, spiders may serve as useful target organisms for monitoring and further study.

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APPENDIX 1

Occurrence of spider morphospecies in rainforest fragments and plantations in the Anamalai hills. Tabled values represent the number of individuals detected in each site. Site codes as in Table 1.

Family	MS No.*	Species	AN	BC	IN	IYAK	IT	KO	MA	PA	PU	TC	TF	V3	Total
Agelenidae	1	*Agelenid sp.1*	0	0	2	0	0	0	1	8	2	0	0	1	14
Agelenidae Total			0	0	2	0	0	0	1	8	2	0	0	1	14
Araneidae	2	*Acusilas sp.*	0	4	44	0	0	0	0	0	0	1	6	2	57
	3	*Arachnura angura*	0	0	0	0	0	0	1	0	0	0	0	0	1
	4	*Araneus diadamatus*	0	0	0	0	0	0	0	0	1	0	0	3	4
	5	*Araneus mitificus*	0	0	5	0	0	0	0	7	5	8	0	1	26
	6	*Araneus nautica*	1	0	0	0	0	0	0	0	0	0	0	1	2
	7	*Araneus sp.* 1 (missing sector)	2	0	0	0	0	0	0	0	0	0	0	0	2
	8	*Araneus sp.* 2 (silver)	0	0	2	0	1	0	0	0	2	1	0	1	7
	9	*Araneus sp.* 3	0	0	0	0	0	1	0	0	0	2	0	0	3
	10	*Araneus sp.* 4	0	0	0	0	0	0	0	0	3	4	0	0	7
	11	*Araneus sp.* 5 (green, orange)	0	3	6	7	10	11	3	14	6	1	3	6	70
	12	*Araneus sp.* 6 (black, orange)	0	0	0	0	0	0	0	0	0	2	0	0	2
	13	*Araneus sp.* 7 (black / white)	0	7	3	0	1	3	0	2	2	5	0	2	25
	14	*Araneus sp.* 8 (cream)	0	0	0	0	1	2	0	4	0	1	0	0	8
	15	*Araneus sp.* 9 (yellow)	3	0	0	0	0	0	0	0	2	0	0	0	5
	16	*Araneus sp.* 10 (silver / orange)	0	0	0	0	2	0	0	0	0	0	0	0	2
	17	*Araneus sp.* 11 (black)	4	1	0	1	1	1	2	0	1	3	2	2	18
	18	*Argiope aemula*	0	1	0	0	0	0	1	0	0	0	0	0	2
	19	*Argiope pulchella*	0	0	0	0	0	0	0	0	0	1	0	0	1
	20	*Argiope sp.* 1 (brown)	0	0	0	0	0	1	0	0	0	0	0	0	1
	21	*Argiope sp.* 2 (cream)	0	2	0	0	0	0	0	0	0	0	0	0	2
	22	*Argiope sp.* 3 (red)	0	1	0	0	0	0	0	0	0	0	0	0	1
	23	*Crytrophora moluccensis*	0	8	0	0	0	0	0	0	0	0	0	0	8
	24	*Crytrophora sp.* 1 (brownish red)	0	1	1	1	1	0	0	0	1	0	1	0	6
	25	*Cyclosa bifida*	0	1	10	2	10	3	1	5	1	4	2	4	43
	26	*Cyclosa confraga*	1	4	0	0	2	3	2	3	0	1	0	2	18
	27	*Cyclosa fissicauda*	0	0	0	0	0	0	0	0	0	0	1	0	1
	28	*Cyclosa insulana*	0	14	1	3	2	0	3	1	4	1	0	1	30
	29	*Cyclosa moonduensis*	2	25	2	0	1	2	0	1	1	1	0	1	36

Family	MS No.*	Species	AN	BC	IN	IYAK	IT	KO	MA	PA	PU	TC	TF	V3	Total
	30	*Cyclosa mulmeinensis*	0	0	1	0	0	1	0	0	0	0	0	0	2
	31	*Cyclosa neilensis*	1	30	6	8	13	11	4	7	13	2	4	10	109
	32	*Cyclosa simoni*	0	1	0	0	0	1	0	0	0	0	0	0	2
	33	*Cyclosa spirifera*	0	23	4	1	2	1	0	1	2	2	1	1	38
	34	*Eriophora sp.*	19	0	0	25	2	0	0	1	4	0	0	0	51
	35	*Eriovixia laglaisei*	0	0	2	0	0	6	0	2	1	0	2	4	17
	36	*Gasteracantha cancriformis*	2	2	3	0	0	0	2	5	2	0	0	0	16
	37	*Gasteracantha dalyi*	0	0	0	0	0	0	1	5	0	3	1	3	13
	38	*Gasteracantha geminata*	0	12	6	0	0	6	0	3	5	12	0	0	44
	39	*Gasteracantha hasseltii*	0	0	0	1	0	0	37	18	0	6	8	5	75
	40	*Gasteracantha kuhlii*	0	0	0	0	0	0	0	0	1	0	0	0	1
	41	*Gasteracantha remifera*	0	0	0	0	0	0	0	0	0	1	3	0	4
	42	*Gasteracantha sp.* 1 (black)	0	0	0	0	0	0	0	0	0	1	0	0	1
	43	*Macracantha arcuata*	0	0	0	0	0	0	2	0	0	0	0	0	2
	44	*Neoscona excelsus*	0	0	0	0	0	1	0	1	0	3	0	0	5
	45	*Neoscona mukerjei*	4	0	0	2	2	0	0	0	1	0	0	0	9
	46	*Neoscona nautica*	3	2	0	0	2	0	2	0	0	0	1	1	11
	47	*Neoscona sp.* 1	0	0	0	0	0	0	0	0	0	0	1	0	1
	48	*Neoscona sp.* 2 (black)	0	1	0	0	0	0	0	0	2	0	0	0	3
	49	*Neoscona sp.* 3 (brown)	4	2	0	0	4	0	1	0	2	0	0	0	13
	50	*Neoscona sp.* 4 (cream)	0	0	0	0	3	0	0	1	1	0	0	0	5
	51	*Neoscona sp.* 5 (maroon)	0	0	0	0	0	0	0	1	0	0	0	0	1
	52	*Neoscona sp.* 6 (orange)	1	0	1	1	0	0	0	0	0	0	0	0	3
	53	*Parawixia dehanii*	1	0	1	0	0	1	0	0	1	0	1	2	7
	54	Unidentified Araneid sp. 1 (green leaf orb)	0	1	0	1	0	0	0	0	0	0	0	0	2
Araneidae Total			48	146	98	53	60	55	62	82	64	66	37	52	823
Clubionidae	55	*Castianeira sp.*	0	0	0	0	1	1	1	0	0	2	0	1	6
	56	*Clubionid sp.* (cream)	5	2	0	1	1	4	1	2	6	3	3	8	36
	57	*Clubionid sp.* (maroon head)	2	1	0	1	0	0	1	6	0	0	1	2	14
Clubionidae Total			7	3	0	2	2	5	3	8	6	5	4	11	56
Ctenidae	58	*Ctenidae sp.*1	0	0	0	1	0	0	0	0	0	0	0	0	1
Ctenidae Total			0	0	0	1	0	0	0	0	0	0	0	0	1
Dictynidae	59	*Dictyna sp.* (leaf web)	0	45	12	2	1	8	2	7	13	4	12	6	112
Dictynidae Total			0	45	12	2	1	8	2	7	13	4	12	6	112

Family	MS No.*	Species	AN	BC	IN	IYAK	IT	KO	MA	PA	PU	TC	TF	V3	Total
Gnaphosidae	60	*Gnaphosa sp.*	0	0	0	2	0	0	1	1	0	0	0	0	4
Gnaphosidae Total			0	0	0	2	0	0	1	1	0	0	0	0	4
Hersiliidae	61	*Hersilia sp.* 1	0	1	1	0	0	1	0	1	0	0	1	1	6
	62	*Hersilia sp.* 2	0	0	0	1	0	0	0	0	0	0	0	0	1
Hersiliidae Total			0	1	1	1	0	1	0	1	0	0	1	1	7
Linyphiidae	63	*Linyphia sp.* (black)	83	9	26	68	34	34	16	34	21	12	48	35	420
	64	*Linyphia sp.* (cream)	4	0	1	0	0	1	1	0	0	1	1	1	10
	65	*Linyphia urbasae*	0	0	0	1	0	0	0	0	0	2	0	0	3
Linyphiidae Total			87	9	27	69	34	35	17	34	21	15	49	36	433
Lycosidae	66	*Hipassa sp.*	0	20	10	0	0	3	0	0	4	0	2	6	45
	67	*Lycosa sp.*	0	3	1	1	1	0	0	0	0	2	0	0	8
	68	*Pardosa sp.*	0	1	0	0	0	0	0	1	0	0	0	0	2
Lycosidae Total			0	24	11	1	1	3	0	1	4	2	2	6	55
Lyssomanidae	69	*Lyssomanes sp.*	9	0	3	7	0	5	1	3	0	1	0	1	30
Lyssomanidae Total			9	0	3	7	0	5	1	3	0	1	0	1	30
Miturgidae	70	*Cheiracanthium sp.* 1	0	0	0	0	0	1	1	0	0	0	0	0	2
	71	*Cheiracanthium sp.* 2 (mottled)	0	0	0	0	0	0	1	1	0	1	0	1	4
Miturgidae Total			0	0	0	0	0	1	2	1	0	1	0	1	6
Oxyopidae	72	*Oxyopes birmanicus* (brown)	0	0	9	0	0	6	2	1	10	10	5	3	46
	73	*Oxyopes sp.* 1 (black, white)	0	0	0	0	0	0	0	0	0	0	0	1	1
	74	*Oxyopes sp.* 2 (orange)	0	1	0	0	0	2	0	0	3	2	0	0	8
	75	*Tapponia sp.* (brown, with egg sac)	0	0	0	0	2	0	1	0	0	0	0	0	3
Oxyopidae Total			0	1	9	0	2	8	3	1	13	12	5	4	58
Pholcidae	76	*Crossopriza sp.*	3	0	1	48	11	2	0	9	2	4	7	5	92
	77	*Smeringopus sp.*	89	0	0	76	21	0	26	40	0	6	28	0	286
Pholcidae Total			92	0	1	124	32	2	26	49	2	10	35	5	378
Pisauridae	78	*Pisaurid (?)*	0	0	0	1	0	0	0	0	0	0	0	0	1
	79	*Pisauridae sp.*	0	0	0	0	0	0	0	0	0	2	0	0	2
	80	*Polyboea vulpina*	0	0	27	7	0	12	4	0	19	0	3	1	73
Pisauridae Total			0	0	27	8	0	12	4	0	19	2	3	1	76
Psechridae	81	*Fecenia sp.*	0	0	0	2	0	0	42	4	0	11	9	7	75
	82	*Psechrus torvus*	20	0	0	46	9	0	95	26	0	1	101	48	346
Psechridae Total			20	0	0	48	9	0	137	30	0	12	110	55	421

Family	MS No.*	Species	AN	BC	IN	IYAK	IT	KO	MA	PA	PU	TC	TF	V3	Total
Salticidae	83	*Attulus sp.*	0	2	0	0	0	0	0	0	0	1	0	0	3
	84	*Bianor sp.*	0	3	2	1	0	0	0	2	1	1	1	4	15
	85	*Evarcha sp.*	1	0	0	1	0	1	0	0	0	1	0	1	5
	86	*Marpissa sp.*	0	1	0	1	0	0	1	0	1	0	0	1	5
	87	*Menemerus sp.*	0	0	1	0	1	0	0	0	0	0	0	1	3
	88	*Myrmarachne sp.* 1	0	0	0	0	0	0	0	0	0	1	0	0	1
	89	*Myrmarachne sp.* 2 (black)	0	1	0	0	1	0	0	0	0	1	0	0	3
	90	*Phidippus sp.*	0	0	0	0	0	0	1	0	0	0	0	0	1
	91	*Plexippus sp.*	0	1	1	0	0	0	0	0	0	0	0	0	2
	92	*Portia semifimbriata*	0	0	0	0	0	0	1	0	0	2	0	0	3
	93	*Portia sp.* 1	0	0	0	0	0	0	1	0	0	0	0	0	1
	94	*Salticidae sp.* 1 (maroon head)	2	3	3	0	3	2	1	1	3	1	1	2	22
	95	*Salticidae sp.* 2 (black abdomen)	0	0	0	1	0	0	0	0	2	0	0	0	3
	96	*Salticidae sp.* 3 (black ant mimic)	0	0	0	0	0	0	2	0	0	0	0	0	2
	97	*Salticidae sp.* 4	0	0	0	0	0	0	0	1	0	0	0	0	1
	98	*Salticidae sp.* 5 (ant mimic)	0	1	0	0	0	0	0	0	0	0	0	0	1
	99	*Salticidae sp.* 6 (cream)	0	0	0	0	0	2	0	0	1	0	0	0	3
	100	*Sitticus sp.*	0	0	0	0	0	0	0	0	0	0	0	1	1
	101	*Telamonia sp.*	0	10	0	0	0	1	4	1	1	11	0	0	28
	102	*Vicaria sp.*	0	0	0	0	0	0	1	0	0	0	0	1	2
Salticidae Total			3	22	7	4	5	6	12	5	9	19	2	11	105
Sparassidae	103	*Olios milleti*	0	0	0	0	0	0	0	1	0	1	0	1	3
	104	*Olios sp.* (brown)	0	1	0	0	0	0	0	0	0	1	0	0	2
Sparassidae Total			0	1	0	0	0	0	0	1	0	2	0	1	5
Tetragnathidae	105	*Herennia sp.*	0	0	0	0	0	0	1	0	0	0	0	0	1
	106	*Leucauge sp. (decorata?)*	4	69	29	3	2	39	34	21	18	88	34	32	373
	107	*Leucauge sp.* 1 (red)	0	0	0	0	0	1	0	0	0	0	1	0	2
	108	*Leucauge sp.* 2 (yellow)	0	0	0	1	0	0	0	0	0	0	0	0	1
	109	*Leucauge tessellata*	1	7	8	6	4	5	5	4	4	4	0	7	55
	110	*Nephila kuhlii*	0	0	0	0	0	0	1	0	0	2	0	0	3
	111	*Nephila like sp.* (cone web)	0	16	8	0	5	25	8	17	25	89	12	2	207
	112	*Nephila pilipes*	1	2	0	0	0	0	0	0	1	40	3	4	51
	113	*Opadometa fastigata*	2	8	4	2	1	3	11	1	4	22	1	3	62
	114	*Tetragnatha sp.* 1	0	0	0	0	0	0	0	0	1	2	0	1	4

Family	MS No.*	Species	AN	BC	IN	IYAK	IT	KO	MA	PA	PU	TC	TF	V3	Total
	115	*Tetragnatha sp.* 2 (black / white)	0	1	0	0	0	0	0	0	0	0	0	0	1
	116	*Tetragnatha sp.* 3 (brown)	0	3	1	0	0	0	1	0	0	0	0	0	5
	117	*Tylorida culta*	8	15	14	9	34	15	9	11	44	20	14	9	202
	118	*Zygeilla sp.*	7	5	0	4	1	0	1	0	0	0	1	0	19
Tetragnathidae Total			23	126	64	25	47	88	71	54	97	267	66	58	986
Theridiidae	119	*Achaearanea mundula*	3	38	13	8	8	8	13	16	5	13	10	5	140
	120	*Argyrodes argentatus*	2	1	1	0	0	1	4	0	4	1	1	1	16
	121	*Argyrodes fissifrons*	0	0	1	0	0	2	0	1	0	0	0	2	6
	122	*Argyrodes flagellum*	1	2	0	1	0	4	1	0	0	0	0	2	11
	123	*Argyrodes flavescens*	0	0	1	0	0	0	1	3	0	1	0	1	7
	124	*Argyrodes sp.*1	0	0	0	0	0	0	1	1	0	0	1	0	3
	125	*Chrysso sp.*	0	0	0	0	0	0	1	1	0	0	1	0	3
	126	*Steatoda sp.*	19	0	0	22	3	0	2	1	2	0	1	0	50
	127	*Theridid sp.* 1 (bottle shaped abdomen)	0	0	1	0	0	0	0	0	0	0	0	0	1
	128	*Theridid sp.* 2 (black distorted abdomen)	2	0	11	2	0	3	1	1	0	6	1	3	30
	129	*Theridid sp.* 3 (black)	6	0	1	3	2	10	4	7	5	2	2	1	43
	130	*Theridid sp.* 4 (heart shaped)	0	13	0	0	1	0	0	0	1	0	0	0	15
	131	*Theridid sp.* 5 (brown)	0	0	1	4	5	4	3	2	1	3	6	3	32
	132	*Theridid sp.* 6 (cream)	5	35	8	18	9	8	8	38	5	5	11	10	160
	133	*Theridid sp.* 7 (step ladder)	1	0	3	2	7	6	1	4	1	12	2	23	62
	134	*Theridid sp.* 8 (green)	0	0	1	0	0	0	0	0	4	0	0	0	5
	135	*Theridula angula*	0	19	11	4	9	8	1	7	5	4	11	7	86
Theridiidae Total			39	108	53	64	44	54	41	82	33	47	47	58	670
Thomisidae	136	*Runicia sp.* (green)	0	0	0	0	0	0	0	0	0	0	1	0	1
	137	*Thomisus sp.* 1 (maroon)	0	0	1	0	0	0	0	0	0	0	0	0	1
	138	*Thomisus sp.* 2 (cream)	0	0	0	0	0	0	0	0	0	1	0	0	1
	139	*Thomisus sp.* 3 (green)	0	0	0	0	3	2	1	3	0	1	0	0	10
	140	*Thomisus sp.* 4 (brown)	0	0	0	0	0	0	0	0	0	3	0	0	3
	141	*Thomisus sp.* 5 (yellow)	0	0	0	0	0	0	0	0	0	0	1	0	1
	142	*Tmarus sp.*	0	0	0	0	1	0	0	0	0	0	0	0	1
Thomisidae Total			0	0	1	0	4	2	1	3	0	5	2	0	18
Uloboridae	143	*Hyptiotes sp.* (brown)	0	0	0	5	0	0	0	0	0	0	0	0	5
	144	*Miagrammopes sp.*	2	0	4	10	5	1	0	0	1	1	0	0	24
	145	*Uloborus sp.* 1 (brown)	3	0	1	6	0	0	0	1	0	0	0	1	12

Family	MS No.*	Species	AN	BC	IN	IYAK	IT	KO	MA	PA	PU	TC	TF	V3	Total
	146	*Uloborus sp.* 1 (brown, commensal)	0	0	0	3	0	0	0	0	0	0	1	2	6
	147	*Uloborus sp.* 2 (cream)	0	0	0	3	1	0	1	0	1	0	4	1	11
	148	*Uloborus sp.* 2 (cream, commensal)	0	0	0	0	0	0	9	0	0	0	13	0	22
	149	*Uloborus sp.* 3 (orange)	1	0	0	0	7	0	30	0	0	0	9	14	61
	150	*Uloborus sp.* 3 (orange, commensal)	0	0	0	8	0	0	10	3	0	0	18	0	39
	151	*Uloborus sp.* 4 (grey)	0	0	0	0	1	0	0	0	0	0	0	0	1
	152	*Uloborus sp.* 5 (yellow)	0	0	0	1	0	0	0	0	0	0	0	0	1
	153	*Uloborus sp.* 6 (tree bark)	4	0	0	14	1	7	24	15	8	0	4	3	80
	154	*Uloborus sp.* 7	1	0	0	0	0	0	0	0	0	0	0	0	1
	155	*Zosis geniculatus*	1	0	4	2	3	4	7	1	4	4	4	8	42
	156	*Zosis geniculatus*? (yellow)	0	0	0	0	0	0	0	0	1	0	0	1	2
Uloboridae Total			12	0	9	52	18	12	81	20	15	5	53	30	307
Grand Total			340	486	325	463	259	297	465	391	298	475	428	338	4565

* MS No. = morphospecies number corresponding to descriptions in Appendix 3.

APPENDIX 2

Spider morphospecies observed opportunistically in rainforest fragments and plantations in the Anamalai hills. Site codes as in Table 1.

Family	MS No.*	Species	AN	BC	IN	IYAK	IT	KO	MA	PA	PU	TC	TF	V3
Araneidae	157	*Cyrtarachne raniceps*			X									
	158	*Cyrtarachne sp. (schmidi?)*									X			
	159	*Gea subarmata*			X									
	160	*Pasilobus kotigeharus*		X										
	161	*Poltys sp.*						X						
Thomisidae	162	*Tibellus sp.*			X			X						

* MS No. = morphospecies number corresponding to descriptions in Appendix 3.

APPENDIX 3
Description of spider morphospecies found during the study in the Anamalai hills

FAMILY AGELENIDAE

1. *Agelenid sp.1* (Size: 12-15 mm)
Resembles members of the family Lycosidae, but the web type and eye arrangement differ from the wolf spiders. The shape of the cephalothorax is also different. Brown with grey markings, abdomen is long and narrow. Prominent spinnerets.
Habit: Delicate sheet web on grass or against rocks, which spreads out, one end, has a tunnel like retreat. The spider sits on the sheet web and at the slightest disturbance will run into its funnel retreat.

FAMILY ARANEIDAE

2. *Acusilas sp.* (Size: 8-11 mm)
Scarlet cephalothorax, dark brown to gray abdomen, black stripes on the legs. White to cream patterned broad band along the length of the abdomen.
Habit: Vertical orb with a missing sector in the upper portion of the orb with a dried leaf suspended in the missing sector with part of its first pair of legs sticking out.
Similar species: Resembles *Phonognatha sp*. of Australia.

3. *Arachnura angura* (Size: 12-15 mm)
Brown with dark brown patterns, the juveniles are shades of yellow. Long elongated tail like posterior end, the tips of which are split. The anterior end has shoulder like projections, which are pointed.
Habit: Vertical orb, spider sits on the hub facing downwards.

4. *Araneus diadamatus* (Size: 12-15 mm)
Dark brown with a darker brown V shaped pattern on the abdomen.
Habit: Vertical orb
Similar species: Resembles *Neoscona mukerji*

5. *Araneus mitificus* (Size: 5-6 mm)
Cephalothorax: Orange
Abdomen: Cream with black markings; anterior end thick black U shaped band, black bands also along the margins, posterior end four black parallel vertical straight bands. Legs are green.
Habit: Vertical or inclined vertical triangle orb with a missing sector, single line retreat passing through the missing sector one end of which is attached to a silken retreat made on a leaf, the spider sits ventral side up on a leaf within this silken retreat.

6. *Araneus nautica* (Size: 10-11 mm)
Could belong to the genus *Neoscona*. Dark brown with an arrow shape on the abdomen. Minute hair on the cephalothorax and abdomen visible.
Habit: Vertical orb

7. *Araneus sp. 1* (missing sector) (Size: 5 mm)
Yellow triangle shape on the abdomen, rest of the abdomen is brown.
Habit: Vertical orb with a missing sector.

8. *Araneus sp. 2* (silver) (Size: 3-4 mm)
Similar to the juvenile *Opadometa fastigata*. The abdomen is silver and the legs have prominent hair on it.

9. *Araneus sp*. 3 (Size: 4-5 mm)
Green and orange. An orange crescent shaped patch present on the ventral side of the abdomen. Male: Green with a silver abdomen.

10. *Araneus sp.* 4 (Size: 5-6 mm)
Green with silver markings.
Habit: Horizontal orb with a silken line retreat to a web. The spider sits within the curled leaf.

11. *Araneus sp*. 5 (green, orange) (Size: 5 mm)
The abdomen is green and orange.
Habit: Horizontal orb web, sometimes vertical webs were also constructed.

12. *Araneus sp*. 6 (black, orange) (Size: 3-4 mm)
Similar patterns to *Opadometa fastigata* but without the pronounced overlapping of the abdomen over the carapace.
Habit: Horizontal orb.

13. *Araneus sp.* 7 (black / white) (Size: 5-6 mm)
The shape of the abdomen is like the genus *Micrathena*. The pattern on the abdomen is a clear 'plus' (+) shape.
Habit: Vertical orb with an open hub. Sometimes a horizontal orb was constructed.

14. *Araneus sp*. 8 (cream) (Size: 6-8 mm)
Abdomen and cephalothorax: Cream. Resembles a *Neoscona*, but the thoracic groove absent.
Habit: Vertical or horizontal orb with a silken line retreat.

15. *Araneus sp.* 9 (yellow) (Size: 6-8 mm)
Yellow abdomen and cephalothorax. Abdomen shape resembles members of the family Linyphidae.
Habit: Structurally similar to *Leucauge* webs, vertical or horizontal orb web with a missing sector and a silken line retreat.

16. *Araneus sp.* 10 (silver / orange) (Size: 3-4 mm)
Silver and orange markings, similar to the juvenile *Opadometa fastigata.*
Habit: Horizontal orb

17. *Araneus sp.* 11 (black) (Size: 3-4 mm)
Black spots on ventral side of the abdomen.
Habit: Vertical or Horizontal orb

18. *Argiope aemula* (Size: 16-19 mm)
Yellow with black wavy and thick white horizontal bands running across the abdomen.
Habit: Vertical orb, spider sits on the hub, cephalothorax and abdomen facing down.

19. *Argiope pulchella* (Size: 11-13 mm)
Thick yellow horizontal bands towards the anterior and posterior ends. Towards the ventral end above a yellow band a black band with red markings is present. The posterior end is broader than the anterior end.
Habit: Vertical orb, spider sits on the hub, head facing down.

20. *Argiope sp. 1* (brown) (Size: 10-12 mm)
Complete spider brown, the margin of the abdomen has a few fringes of hair.
Habit: Vertical orb, spider sits on the hub, head facing down.

21. *Argiope sp*. 2 (cream) (Size: 10-12 mm)
Complete spider cream, the posterior end of the abdomen has two pairs of sigilla present.
Habit: Vertical orb, spider sits on the hub, head facing down.

22. *Argiope sp*. 3 (red) (Size: 8-10 mm)
Abdomen and cephalothorax is bright red, the abdomen has a few black markings towards the posterior end. There are prominent black spines on the legs.
Habit: Vertical orb, spider sits on the hub, head facing down.

23. *Cyrtophora moluccensis* (Size: 8-9 mm)
Oval and the dorsal side decorated with numerous small white spots.
Habit: The web is a complicated structure with a dome and below that another upside down dome. There are scaffolds above the dome and the spider sits below the first dome, legs outstretched.

24. *Cyrtophora sp.* 1 (brownish red) (Size: 18-20 mm)
Uniformly brownish red, one pair of humps towards the anterior end of the abdomen.
Habit: *Crytrophora* type dome web but the spider sits within a retreat made of a bunch of dried leaves suspended in the middle of the web.
Similar species: *Crytrophora unicolour* of Singapore.

25. *Cyclosa bifida* (Size: 10-12 mm)

Black with a long blunt tail like extension towards the posterior end of the abdomen. The only *Cyclosa* species in this list with no paired tubercles present. Its elongated blunt tail sometimes curls upwards when disturbed and was often found sitting sideways on the hub of the web. One male found on the web and was similar but only about 6-7 mm.
Habit: Vertical orbs, lower in the vegetation, if debris was present only a little around the hub of the web.

26. *Cyclosa confraga* (Size: 5-6 mm)
Similar to *C. bifida* but the abdomen is broader and there is one pair of tubercles present towards the posterior end. Black and silver markings present on the abdomen.
Habit: Vertical orb.

27. *Cyclosa fissicauda (=Cyclosa quinqueguttata)* (Size: 4-5 mm)
Globular compared to other *Cyclosa* species. Brown with silver markings on the abdomen and one distinct pair of tubercles in the middle.
Habit: Vertical orb with debris along the hub.

28. *Cyclosa insulana* (Size: 7-10 mm)
Short and broad with a blunt caudal tail. On either side of this tail there are blunt projections posteriorly. Dark brown and maroon with silver markings on the dorsal side.
Habit: Vertical orb with steblimentum around the hub, spider sits along with the debris.

29. *Cyclosa moonduensis* (Size: 6-8 mm)
The caudal tail towards the posterior end is forked making it look like a fish tail. There are also two pairs of humps towards the posterior end. This gives the abdomen a star shaped appearance.
Habit: Vertical orb.

30. *Cyclosa mulmeinensis* (Size: 4-5 mm)
Very short and more globular than *C. insulana*, with a short pointed caudal tail. Brown with some black patches.
Habit: Vertical orb.

31. *Cyclosa neilensis* (Size: 4-5 mm)
Posterior part cone shaped, most striking part of this spider is the bright silver abdomen, sometimes with indistinct grey patterns. The cephalothorax is grey. Similar to *C. sedeculata* from Japan.
Habit: Vertical triangle orb, sometimes a circular stabilimentum is present around the hub. If debris is present there are only faint traces of it.

32. *Cyclosa simoni* (Size: 7-8 mm)
Cone shaped and longer than wide with white and brown markings on the abdomen. The anterior end has a hump in the middle. The posterior end has a caudal pointed hump and one pair of small lateral humps just above the caudal end.
Habit: Vertical triangular orb.

33. *Cyclosa spirifera* (Size: 7-8 mm)
Brown with orange and white markings. One pair of prominent lateral humps just above the long caudal tail.

Habit: Vertical orb with debris strung across one end of the orb to the other and passing through the hub. A few individuals also had circular steblimentum around the hub.

34. *Eriophora sp.* (Size: 9-11 mm)
Its habits resemble that of an Argiope, but the last two pairs of legs are not kept apart but touch each other behind when the spider is in the hub of the web. The anterior end has a pair of pointed shoulder protrusions. Habit: Vertical orb, if steblimentum is present then it is on the opposite sides of the hub.
Similar species: *Eriophora astridae* of Japan.

35. *Eriovixia laglaisei* (= *Neoscona laglaisei*) (Size: 5-9 mm)
Yellow in adults with a fuzzy white star like pattern on the abdomen. Also has a prominent tail like extension at the posterior end, making the abdomen cone shaped, the abdomen being much broader in the middle. The abdomen is hairy throughout. Cephalothorax is orange.
Habit: Vertical orb, spider sits on the hub or away from the web with its legs folded next to its abdomen.

36. *Gasteracantha cancriformis* (= *Gasteracantha mammosa)* (Size: 6-7 mm)
Rounder than all other Gasteracantha species. Wider than long. Two pairs of outward projections along the margins, these projections not as prominent as the other Gasteracantha species. White with black patches. One pair of round black patches in the middle of the dorsal side of the abdomen. Cephalothorax and legs reddish brown.
Habit: Vertical orb with an open hub.

37. *Gasteracantha dalyi* (Size: 9-10 mm)
Yellow with black spots. Prominent long median spines, the anterior and posterior spines much smaller, all of them black.
Habit: Vertical or horizontal orb with an open hub.

38. *Gasteracantha geminata* (Size: 7-8 mm)
Oval, broadest at the middle, wider than long. The two pairs of spines in the middle as almost the same length and situated close together. Three white and yellowish horizontal bands running across the abdomen with a black and red tinge in between these white bands.
Habit: Horizontal orb with an open hub. Very often the web was found to be decorated with round fuzzy silk balls on one strand passing through the hub or only towards one end and/ or along the frame of the web.

39. *Gasteracantha hasseltii* (Size: 8 mm)
Yellow and white, outer margins are brownish red with black and brownish red patches. Smaller than the other *Gasteracantha* species with three pairs of spines almost similar in length except the median pair that is slightly longer. The spines and the abdomen sometimes have a dark blue tinge, otherwise they are black. The legs are striped white and black. The juveniles were very often encountered and are red to reddish maroon. The males look similar to the juveniles.
Habit: Vertical orb with an open hub.

40. *Gasteracantha kuhlii* (Size: 5-6 mm)
Blackish brown with three pairs of equal length spines. Wider than long and has yellowish white patches.
Habit: Vertical orb with an open hub.

41. *Gasteracantha remifera* (Size: 9 mm)
Similar to *Gasteracantha dalyi* but the mid dorsal spines are shorter and thinner, but not so pointed at the tips. Abdomen is yellow with black to brown patches.
Habit: Vertical orb with an open hub.

42. *Gasteracantha sp.* 1 (black) (Size: 5-6 mm)
Black with a white cross shape on the abdomen.
Habit: Vertical orb with an open hub.

43. *Macracantha arcuata* (Old: *Gasteracantha arcuata*) (Size: 10 mm)
Yellow with brown and black patches. One pair of very long and prominent spines which curves. The other two anterior and posterior pairs are small and hardly noticeable.
Habit: Vertical orb with an open hub

44. *Neoscona excelsus* (= *Eriovixia excelsus)* (Size: 4-5 mm)
Similar to juvenile of *Opadometa fastigata*, the most noticeable mark is the prominent pair of round red dots on black on the ventral side of the abdomen. Dorsal side is orange and black. The abdomen is wider than long and the posterior end has a small tail like extension.
Habit: Horizontal orb, spider positioned in the hub facing downward, the ventral side more often noticed.

45. *Neoscona mukerjei* (Size: 9-10 mm)
Sub triangular in shape and overall dark brown. From the middle of the dorsal side to the posterior end there is a dark brown wavy thick patch. The posterior end is slightly pointed, the spider sits within or on a leaf retreat with its legs close to the abdomen.
Habit: Vertical orb with a missing sector and a drag line, the other end attached to the leg of the spider.

46. *Neoscona nautica* (Size: 10-11 mm)
Similar to *N. mukerjei* but with a very clear and prominent upward pointing thick arrow shaped mark on the abdomen. Overall cream to brown.
Habit: Vertical orb with a missing sector and a drag line, the other end attached to the leg of the spider.

47. *Neoscona sp*. 1 (Size: 6-7 mm)
Overall dark brown with a white crescent like shape marking on the abdomen. The legs have black and white stripes.
Habit: Vertical orb with widely spaced radials and spikes.

48. *Neoscona sp.* 2 (black) (Size: 6-7 mm)
Abdomen and cephalothorax black, abdomen with shades of orange and a white mark, the shape resembles the abdomen of *Crytarachne* sp.
Habit: Few web strands, spider found on the lower surface of leaf.

49. *Neoscona sp.* 3 (brown) (Size: 6-7 mm)
Similar to *N. mukerjei* and *N. nautica* but smaller. The ventral side of the abdomen has a black marking with a pair of white dots. Overall dark brown.
Habit: Vertical orb with a missing sector and a drag line, the other end attached to the leg of the spider.

50. *Neoscona sp*. 4 (cream) (Size: 6-7 mm)
This species could be a variation of Neoscona sp. 3 (brown). Similar in size and habits.
Habit: Vertical orb with a missing sector and a drag line, the other end attached to the leg of the spider.

51. *Neoscona sp*. 5 (maroon) (Size: 10-11 mm)
Overall maroon with a black 'V' shaped wavy mark on the abdomen. One pair of sigilla present towards the anterior end.
Habit: Complete vertical orb with an open hub

52. *Neoscona sp*. 6 (orange) (Size: 10-11 mm)
Could be a variation of Neoscona sp. 5 (maroon), has the same wavy 'V' shaped mark on the abdomen but the sigilla seems absent.
Habit: Complete vertical orb with an open hub, few strands leading to a leaf retreat within which it sits.

53. *Parawixia dehanii* (Size: 18-20 mm)
Anterior end of the dorsal side of the abdomen has a pair of two horn like projections the tips of which are sometimes red. The posterior end tapers to a V. The cephalothorax and abdomen have prominent hair and is clearly visible. Overall brown to dark brown with an outward projecting cephalic region. The legs are thick and have a red tinge to them and when at rest hold them close to the body.
Habit: Large vertical orb with widely spaced radials, nocturnal species and so rebuilds or fixes its web at night. Traces of the web are visible in the day and if a strand is traced back to the retreat the spider can be seen, resembles a dried leaf.

54. Unidentified Araneid sp. 1 (green leaf orb) (Size: 3-4 mm)
The ventral side of the spider is bright green, the dorsal is black, the genus could not be identified.
Habit: Small compact orb web on the upper surface of a leaf, spider sits on the downward facing side of the web, the ventral side facing up.

FAMILY CLUBIONIDAE
55. *Castianeira sp.* (Size: 5 mm)
The only genus in this family which was found outside its leaf retreat and actively foraging. An ant mimic of the species *Camponotus serretius*. Black with faint white bars on the dorsal side of the abdomen. The abdomen towards the anterior end dips (forms a slight depression) and then rises again. The spinnerets are long and prominent. The spider was often found on coffee bushes.
Habit: Active foliage hunters

56. *Clubionid sp.* (cream) (Size: 4-5 mm)
Long conical spinnerets, resembles the Gnaphosid family but the abdomen is not flat like the Gnaphosid. Cream and sometimes with white speckles. The legs are long with sparse and prominent spines. Rests with its first three pairs of legs pointing forward and the last pair facing back. The male have long black outward projecting chelicerae and the abdomen is a little narrower than the female.
Habit: They are active hunters, but most often during the day they are found only in the silken retreats which they make by rolling a leaf and lining it with silk. This retreat is open at both ends and the spider sits within it.

57. *Clubionid sp*. (maroon head) (Size: 5-6 mm)
Similar to Clubionid sp. (cream) but with a maroon cephalothorax and the abdomen is longer. The abdomen is gray and the conical spinnerets prominent. The legs are long with prominent sparse spines.
Habit: This species also constructs a silken leaf retreat within a rolled leaf.

FAMILY CTENIDAE
58. *Ctenidae sp.1* (Size: 12 mm)
They resemble wolf spiders of the family Lycosidae. Wandering spiders found on the leaf litter. They are much faster though and difficult to catch. The eye arrangement and shape of the cephalothorax is also very different from Lycosids. The cephalothorax has parallel ventral dark bands running along it, and the chelicerae are brightly coloured. Brown with some dark patches on the abdomen.

FAMILY DICTYNIDAE
59. *Dictyna sp*. (leaf web) (Size: 4-5 mm)
Resembles the Japanese *Dictyna sp*. The ventral side has a thick black or green band running along the length of the abdomen.
Habit: It builds an irregular with many criss- cross silken threads, always on the upper surface of a leaf. The spider sits below the irregular web with its ventral side facing upwards.

FAMILY GNAPHOSIDAE
60.*Gnaphosa sp.* (Size: 10-12 mm)
Resembles a Clubionid but the abdomen in a Gnaphosid is longer and flatter. Long prominent spinnerets are also present but are wider apart, whereas in a Clubionid they are close together. Uniformly brown with stout legs.
Habit: Wandering hunting spiders they are found on leaf litter, or sometimes under a loose bark on a tree.

FAMILY HERSILIIDAE
61. *Hersilia sp.* 1 (Size: 9-10 mm)
Always found on the barks of trees, head facing downwards. The oval shaped abdomen is flat and the colour of the spider often matches the bark of the tree it is found on, making it difficult to spot. A very prominent feature is the very distinctive long spinnerets unique to this family.

62. *Hersilia sp.* 2 (Size: 7-8 mm)
Similar to *Hersilia sp*. 1 but the abdomen is more oval and there are prominent black markings on the abdomen. It is also slightly smaller than *Hersilia sp*. 1.

FAMILY LINYPHIIDAE
63. *Linyphia sp.* (black) (Size: 4-5 mm)
Whole spider black except with two white patches on the abdomen. The middle has a slight depression and then elevates towards the posterior end. Cephalic region is elevated and also black.
Habit: Hammock/flat with a dome above and scaffolds holding up both the dome and the platform.
The spider sits ventral side facing up below the hammock.

64. *Linyphia sp.* (cream) (Size: 4-5 mm)
Similar to Linyphia sp. (black), but the ventral side has a few light red markings with some silver patches.
Habit: Hammock/flat with a dome above and scaffolds holding up both the dome and the platform.
The spider sits ventral side facing up below the hammock. A little more irregularly shaped.

65. *Linyphia urbasae* (Size: 5-7 mm)
Bright yellow with a pair of thick black longitudinal patches towards the anterior side, and thin black horizontal bands across and a black patch towards the ventral side. Cephalothorax red and the thin long legs have black and red stripes across.
Habit: Irregular silken strands strung below a leaf, the spider sits below the leaf surface.

FAMILY LYCOSIDAE
66. *Hipassa sp.* (Size: 9-11 mm)
Greenish brown overall, white thick bands run along the sides of the cephalothorax joining between the first and second row of eyes. Abdomen has black markings.
Habit: Sheet web with a tubular tunnel retreat usually above grass or against a small rock surface.

67. *Lycosa sp*. (Size: 7-10 mm)
This genus can be confused with the genus *Pardosa*, but if carefully examined the cephalic and cephalothorax region is much wider in the *Lycosa sp*. White thick bands can be found along the margin of the cephalothorax. Brown and dark brown markings on the cephalothorax and abdomen.
Habit: Active hunter on leaf litter.

68. *Pardosa sp*. (Size: 10 mm)
Only looking at the eye arrangement and cephalothorax shape can one differentiate the Pardosa genus from Hipassa. The posterior median eyes are much larger than the others. Dull brown colouration.
Habit: Active hunters on leaf litter.

FAMILY LYSSOMANIDAE
69. *Lyssomanes sp*. (Size: 9-11 mm)
Very similar to the family Salticidae, it is placed in a separate family because the eyes are in four rows, unlike the three rows in Salticidae. It is strikingly green and has an elongated abdomen, longer than wide and has a few pairs of dark patches along the length. The eyes in four rows are surrounded by black margins making the cephalic region dark. The legs are long stout and hairy.
Habit: Active foliage hunter, often found on the leaf surfaces of shrubs, and with the slightest disturbance fall on the leaf litter or hide under the surface of a leaf. Moves very fast and often sideways.

FAMILY MITURGIDAE
70. *Cheiracanthium sp.* 1 (Size: 9 mm)
Resembles members of the family Clubionidae, but have longer and thicker first pair of legs. The chelicerae are strong and prominent and outward projecting. The abdomen is long and cylindrical and mottled with brown and white. Long and prominent spinnerets.
Habit: Active foliage hunters, nocturnal. Found in silken leaf rolled retreats. Sits with its first two pairs of legs pointing forward and the last pair pointing back.

71. *Cheiracanthium sp*. 2 (mottled) (Size: 9-10 mm)
Similar to Cheiracanthium sp. 1, this species has chelicerae that are dark blue and outward projecting. Abdomen is mottled with cream and brown markings and the first pair of legs longer and stronger than the rest.
Habit: Same as Cheiracanthium sp. 1.

FAMILY OXYOPIDAE
72. *Oxyopes birmanicus* (brown) (Size: 7 mm)
Was the most abundant among the Oxyopids. Hexagonal eye arrangement and they are all dark coloured. Shades of light and dark brown with a prominent dark brown 'V' shaped marking on the abdomen. The cephalic region is slightly elevated and black patterns are present between the cephalic region and chelicerae. Prominent black spines on the legs.
Habit: Active foliage hunters, at the slightest movement they either jump with a safety line attached or raise its first pair of legs in threat.

73. *Oxyopes sp. 1* (black, white) (Size: 8-9 mm)
Black and white stripes and is longer and narrower than *Oxyopes birmanicus*, otherwise looks similar. Prominent black spines on the legs.
Habit: Active foliage hunters, at the slightest movement they either jump with a safety line attached or raise its first pair of legs in threat.

74. *Oxyopes sp.* 2 (orange) (Size: 8-9 mm)
Orange with very light cream and black wavy markings on the abdomen. Male has prominent, long and black palps. Abdomen is long and narrow. Prominent black spines on the legs.
Habit: Active foliage hunters, at the slightest movement they either jump with a safety line attached or raise its first pair of legs in threat.

75. *Tapponia sp.* (brown, with egg sac) (Size: 7-9 mm)
Not as long and narrow as the other Oxyopid species, but rounder and stout. The cephalothorax though is wider than long. The legs have long prominent spines.
Habit: Always found on a leaf guarding her white egg sac by sitting on it and the leaf is suspended by two silk strands attached to vegetation.

FAMILY PHOLCIDAE
76. *Crossopriza sp.* (Size: 7-9 mm)
The family can be easily be recognized by its web and the long slender legs, the joints have a dark colouration. Globular abdomen and towards the posterior end the abdomen gets pointed so that the spinnerets look prominent and pointed. The ventral side has red round dots, some individuals had black. Superficially could be mistaken for a

Theridid. Other parts are cream. In the male the red dot is absent on the ventral side.
Habit: Cob web weavers, construct irregular silken strands attached to the lower surfaces of leaves. The silken strands radiate outwards. The web of this species sometimes has round globule like transparent structures attached to it.

77. *Smeringopus sp.* (Size: 4 mm)
Similar to *Uthina atrigularis* of Singapore, long and cigar shaped. The middle forms a depression and towards the posterior end the abdomen rises again at a higher elevation than the rest of the spider. Overall light green with faint black and cream patches.
Habit: Dense irregular silken strands attached to the base of a leaf and radiating outwards, structure resembles a tent sometimes.

FAMILY PISAURIDAE
78. *Pisaurid* (?) (Size: 7-8 mm)
Resembled a Pisaurid, but only had one detection of this species and hence a full description was not possible.

79. *Pisauridae sp*. (Size: 7-8 mm)
Resembles members of the family Agelinid by their web structure and morphologically like the Lycosids. Prominent, long and dense hairs on the legs. Long abdomen and parallel stripes on the cephalothorax.
Habit: Sheet web with a funnel like retreat.

80. *Polyboea vulpina* (Size: 8-9 mm, male 10 mm).
Resembles the species found in Singapore. Males were found more often and towards the latter part of the sampling period. Legs have short spines, the median eyes are bigger than the rest, the cephalothorax region and the chelicerae are on the same plane. Overall brownish red, and shaped like a Clubionid.
Habit: Active foliage hunters, they move very fast and drop or go under a leaf and hide at the slightest disturbance, scuttles like a Sparrasid.

FAMILY PSECHRIDAE
81. *Fecenia sp*. (Size: 10-12 mm)
Resembles members of the family Dictynidae, this group belongs to the cribellate order; a sieve like organ is present just above the spinnerets. Female is greenish brown overall, legs are longer and are kept close and bent to the abdomen. The first pair of legs are much longer than the rest, the third pair the shortest. There is a 'V' shaped pattern on the anterior dorsal side of the abdomen. The legs have black stripes. The male is slightly smaller and brownish grey, but is otherwise similar to the female.
Habit: Irregular vertical cribellate web with zig zag patterns and towards the end faint orb like patterns are visible. In the middle of this web a dried leaf lies suspended and the spider sits within it, head facing downwards.

82. *Psechrus torvus* (Size: 12- 15-20 mm)
Longer than wide, with a depression towards the middle and then a rise again towards the ventral part. Light an dark brown with black and white patches. One pair of irregular black bands runs along the length of the abdomen. Spinnerets are prominent. Cephalothorax is green with a V shaped marking and parallel green bands on either side of this V shaped mark. There are also green bands along the margins of the cephalothorax. Legs very long and slender with a few prominent spines. Ventral: Three white bands running along the length of the abdomen, all of them guarded by black bands.
Habit: Large, prominent cribellate sheet web. It spreads outwards and towards the narrow end has a tubular retreat within which the spider makes a hasty retreat. Runs ventral side up in the lower surface of the web and hence the ventral part is visible more often. Web usually found against tree bark and rocks.

FAMILY SALTICIDAE
83. *Attulus sp.* (Size: 3-4 mm)
Resembles a bee when sitting still on foliage. Fourth pair of legs longer than the others. Black with some white patterns.
Habit: Active foliage hunters

84. *Bianor sp*. (Size: 3-4 mm)
Maroon and with stripes along the abdomen. White stripes on the cephalothorax and along the sides. First pair of legs enlarged and covered with a thick brush of hairs. High cephalothorax and with a white stripe below the cephalic region and above the chelicerae.
Habit: Active foliage hunters

85. *Evarcha sp*. (Size: 8-9 mm)
Brown with cream and light brown markings. Cephalothorax of female has a pair of 'horns' that is actually bristles of hair.
Habit: Active foliage hunters

86. *Marpissa sp*. (Size: 6-9 mm)
Long and straight. Legs short and stout and first pair hairier than the rest. Cream with light brown markings.
Habit: Active foliage hunters

87. *Menemerus sp*. (Size: 8- 10 mm)
Similar to *Plexippus*, white bands along the cephalothorax. Yellow to brown to white stripe between the cephalic region and chelicerae.
Habit: Active foliage hunters

88. *Myrmarachne sp*. 1 (Size: 6-7 mm)
Orange with some black markings, mimics the red weaver ant. Male has an elongated chelicerae.
Habit: Active foliage hunters

89. *Myrmarachne sp. 2* (black) (Size: 7-8 mm)
Mimics the black *Camponotus* ant. The cephalothorax is squareish; the abdomen is constricted towards the anterior and.
Habit: Active foliage hunters

90. *Phidippus sp*. (Size: 10-12 mm)
Big Salticids, the first pair of legs is very hairy and the palps are also hairy. Dark brown with cream markings.
Habit: Active foliage hunters

91. *Plexippus sp*. (Size: 10- 11 mm)
Male is black with white vertical stripes on the cephalothorax and abdomen. Female is brown with a thick light brown to cream band in the middle of the abdomen.
Habit: Active foliage hunters

92. *Portia semifimbriata* (Size: 6-9 mm)
Found on the webs of other spiders. Feeds on other spiders by invading their webs. The palps have white fuzzy hair and the middle of the cephalothorax has a cone shape on top. The abdomen also has lots of protrusions. Dark brown with light brown markings.
Habit: Active foliage hunters

93. *Portia sp.* 1(Size: 6-7 mm)
Smaller than *Portia semifimbriata* but the white hair on the palps not present.
Habit: Active foliage hunters

94. *Salticidae sp.* 1 (maroon head) (Size: 5-6 mm)
Brown crescent shape marking on the abdomen, cephalothorax maroon.
Habit: Active foliage hunters

95. *Salticidae sp*. 2 (black abdomen) (Size: 5-6 mm)
Black and the shape of the abdomen and cephalothorax are like that of *Plexippus*.
Habit: Active foliage hunters

96. *Salticidae sp.* 3 (black ant mimic) (Size: 4-5 mm)
Resembles *Casterneira sp*.of family Clubionidae. The cepalothorax is not squarish and elevated like *Myrmarachne sp*. 2 (black).
Habit: Active foliage hunters

97. *Salticidae sp.* 4(Size: 5-6 mm)
Only one individual seen, could not get a description.

98. *Salticidae sp.* 5 (ant mimic) (Size: 6-7 mm)
Mimics the ant Camponotus sp. The abdomen like that of an ant also has a golden tinge. Resembles a Clubionid in shape more than a Salticid.

99. *Salticidae sp.* 6 (cream) (Size: 6-7 mm)
Similar to *Plexippus sp*. but is hairier and is cream completely.

100. *Sitticus sp.* (Size: 5-6 mm)
Sits like a crab, overall blueish black, yellow to white dots on the abdomen, white cephalic stripe.

101. *Telamonia sp*. (Size: 9-11 mm)
Longer than wide and narrow. Female white with pink stripes on the abdomen; male black and red stripes on the abdomen. Cephalic region elevated. Spinnerets are prominent.
Habit: Active foliage hunters

102. *Vicaria sp*. (Size: 8-9 mm)
Cream strip on abdomen which is long and pointed, the ventral part repeatedly points upwards. The first pair of legs is longer and stronger and there is a mustache stripe on the sides below the cephalic region, this stripe is not joined.
Habit: Active foliage hunters

FAMILY SPARASSIDAE
103. *Olios milleti* (Size: 13-17 mm)
Carapace and abdomen flat and when disturbed they scuttle like a crab, also sit crab like but their legs are thinner longer and have long prominent spines than the spiders of the family Thomisidae. The abdomen and carapace are green. The cephalic (eye) region have white markings around it.
Habit: Active hunters and are typically found on leaf litter or on the barks of trees.

104. *Olios sp.* (brown) (Size: 13-15 mm)
Similar to *Olios milleti*, but the cephalothorax and abdomen are brown. The cephalothorax has a white band along the margins. Flat body and the posture is crab like.
Habit: Active hunter on leaf litter.

FAMILY TETRAGNATHIDAE
105. *Herennia sp.* (Size: 12- 15 mm)
The margin of the abdomen is serrated to form four pairs of lateral lobes. Overall it is oval and white with black patterns, folia is also present. Chelicerae are black thick and prominent.
Habit: Orb web weavers on tree barks. It is difficult to spot the web which is longer than broad.

106. *Leucauge sp.(decorata?)* (Size: 9-10 mm)
Description comes closest to *L. decorata*, but it does not match exactly especially the two prominent shoulder humps at the anterior end of the abdomen. Dorsal side silver with black long bands along the abdomen. Cepahlothorax green, ventral side with a green median longitudinal stripe.
Habit: Orb web weavers

107. *Leucauge sp.* 1 (red) (Size: 7-8 mm)
Bright red, double fringe of hairs on the fourth leg.
Habit: Was not found on a web but in a retreat.

108. *Leucauge sp.* 2 (yellow) (Size: 9-10mm)
Dorsal side silver with brown patches. The sides of the abdomen and bits of the ventral side is bright yellow.
Habit: Vertical orb with a single line retreat, spider does not sit on the hub

109. *Leucauge tessellata* (Size: 9-10 mm)
Elongated and squarish at the anterior end with two blunt shoulder protuberances, narrowing down towards the posterior end, but not pointed at the tip, but forming a blunt caudal hump. Black median stripe on silver and the margins also decorated with black and yellow patches. The anterior and posterior end has a black patch. Fourth pair of legs with prominent black double fringe of hairs. Ventral side with a green median longitudinal line.
Habit: Horizontal orb with an open hub.

110. *Nephila kuhlii* (Size: 35-37 mm)
Long, cylindrical, slightly overlaps over the carapace. Very faint mid longitudinal line on a jet back abdomen. Legs are yellow with red patches at the joints. Cephalothorax black to reddish brown. Chelicerae black, thick and prominent.
Habit: Large vertical orb with widely spaced radials and spirals.

111. *Nephila like sp*. (cone web) (Size: 6-7 mm, male 5-6 mm)
Thin and long posterior end turning downwards to a dull point and the anterior end slightly overlaps over the carapace. The black abdomen has a pair of longitudinal yellow stripes running along the length. The ventral part has a black median longitudinal line framed by white.
The chelicerae are black thick and prominent. Male smaller and the ends of the palps prominent and narrow down to a long pointed tip.
Habit: Vertical orb web, with a cone like structure protecting one side of the web, which is also an orb.

112. *Nephila pilipes* (Size: 35-38 mm)
Longer than wide and cylindrical. Dorsum of abdomen has a pair of prominent longitudinal yellow lines and laterally with yellow patches and lines. Few pairs of sigilla present. Legs long, strong, black and with prominent spines, the joints are red. Ventral part yellow with black patches and red around the spinnerets.
Habit: Large vertical orb with widely spaced radials and spirals.

113. *Opadometa fastigata* (Size: 8-9 mm)
Anterior part overlaps strongly over the carapace and forms a broad and blunt shoulder hump. Posterior end also broad and does not taper. Orange, black and silver patches decorate the abdomen. Chelicerae thick and black.
Habit: Vertical or horizontal orb with an open hub.

114. *Tetragnatha sp*. 1 (Size: 10- 12 mm)
Long and narrow, chelicerae are long and elongated. Light yellow with a mid longitudinal black line along the abdomen and other black splotches.
Habit: Horizontal orb, hub is attached to a twig and the spider sits on the hub and rests on the twig legs outstretched.

115. *Tetragnatha sp.* 2 (black / white) (Size: 9- 10 mm)
Black with a white longitudinal mid dorsal patch.
Habit: Horizontal orb

116. *Tetragnatha sp.* 3 (brown) (Size: 9-10 mm)
Dark brown with no markings. Long, narrow with elongated chelicerae. Sits with legs outstretched, first two pairs in front and the other two pairs pointing backwards.
Habit: Vertical orb on grass, open hub and attached to grass stalk.

117.*Tylorida culta* (Size: 3.5-4 mm)
Silver with a median black to brown band along the length. Towards the posterior end three pairs of black spots with stalks, the black spots getting larger with the last pair. Extreme posterior end black patch in the middle. Cephalothorax and legs are green; the joints tend to be brown.
Habit: Vertical or horizontal orb with an open hub. Some individuals with strands of steblimentum along the spiral threads next to the hub.

118. *Zygeilla* sp. (Size: 5 mm)
Brown to gray with black and white markings, a wavy outline forming a U shape. Oval and covered with minute hairs. The chelicerae are black, thick and prominent. The cephalothorax is also black.
Habit: Vertical orb with a missing sector in the upper half. A single strand runs through this missing sector and the spider present either within a leaf retreat or was found sitting on a twig nearby.

FAMILY THERIDIIDAE
119. *Achaearanea mundula* (Size: 4-5 mm)
Globular and orange with brown patches. Male, darker orange cephalothoax and brown on the abdomen but no patterns.
Habit: Tent like web with a sheet below and scaffolds. Usually a dried leaf suspended in the middle and the spider sits within it cephalothorax facing downwards. Any disturbance to the web or leaf and the spider will drop from the web.

120. *Argyrodes argentatus* (Size: 2.5-3 mm)
Triangle shape and silver pointing upwards, narrowing above.
Habit: A commensal on the webs of Araneidae and Linyphiidae.

121. *Argyrodes fissifrons* (Size: 7-8 mm)
Triangle shaped dark brown to black, not a commensal.
Habit: Irregular web strands, sits below a leaf first pair of long legs pointing forward.

122. *Argyrodes flagellum* (Size: 18-20 mm)
Very long and narrow abdomen, elongated beyond the spinnerets, resembles a stick. Legs very short, the ventral part sometimes curls, the spinnerets on the ventral side prominent and pointed.
Habit: Single line web or irregular web strands.

123. *Argyrodes flavescens* (Size: 5 mm)
Red slightly constricted in the middle. First pair of legs longer than the rest.
Habit: Commensal on Araneid and Theridid webs.

124. *Argyrodes sp.*1(Size: 3-4 mm)
Yellow to golden triangular abdomen.
Habit: Commensal on Araneid webs

125. *Chrysso sp*. (Size: 8-9 mm)
Triangular shaped narrowing to the spinnerets. Silver with dark brown markings patches and decorations. Legs with prominent long hair and spines. The posterior part narrowing to a 'V', the abdomen also covered with hair.
Habit: Irregular silk web strands.

126. *Steatoda sp*. (Size: 4-5 mm)
Globular like a Theridion, maroon and brown with white markings; one vertical line not covering the whole abdomen and horizontal lines cutting across it. Males have a less globular abdomen but same patterns.
Habit: Sheet web just above the ground usually against a rock with a funnel like retreat.

127. *Theridid sp.* 1 (bottle shaped abdomen) (Size: 3-4 mm)
Long, narrow and bottle shaped. Black and comparatively small legs and cephalothorax.
Habit: Found climbing on its long irregular web strands upwards.

128. *Theridid sp.* 2 (black distorted abdomen) (Size: 3-4 mm)
Similar to Theridid sp. 1 (bottle shaped abdomen) but the abdomen has a depression in the middle and then rises again much above the plane of the cephalic region.
Habit: Commensals on webs of other spiders or constructs irregular scaffolding web strands.

129. *Theridid sp.* 3 (black) (Size: 3-4 mm)
Globular, similar to *Theridula angula* but completely black. Long slender black legs.
Habit: Irregular web strands which criss cross and sometimes bits of debris of tree bark, dried leaf bits and flower parts suspended in the middle, spider sits within this.

130. *Theridid sp.* 4 (heart shaped) (Size: 3-4 mm)
Heart shaped, broader than long, black, some individuals with orange to red markings.
Habit: Irregular web strands, sit below a leaf.

131. *Theridid sp*. 5 (brown) (Size: 3-4 mm)
Globular, brown to gray shades with cream speckles.
Habit: Irregular criss cross web strands, sometimes with a retreat made of debris suspended in the middle.

132. *Theridid sp.* 6 (cream) (Size: 3-4 mm)
Globular, entire spider cream, abdomen has black prominent spots.
Habit: Irregular criss cross web strands, sometimes with a retreat made of debris suspended in the middle.

133. *Theridid sp.* 7 (step ladder) (Size: 3-5 mm)
Globular, gray to brown with wavy cream markings along the length of the abdomen.
Habit: Web strands radiating outwards in squarish formations and sometimes resembles a step ladder. One portion of the web, the starting either has a small retreat or it sits on a twig with silk surrounding it.

134. *Theridid sp.* 8 (green) (Size: 3-4 mm)
Globular, resembles a Pholcid, with long slender legs.
Habit: Irregular web strands

135. *Theridula angula* (Size: 3-5 mm)
Orange and globular, middle of the abdomen with a pair of blunt protuberances the tips of which are black, giving the abdomen a triangular appearance.
Habit: Irregular scaffolding strands sometimes with a silken sheet below.

FAMILY THOMISIDAE

136. *Runicia sp.* (green) (Size: 5-6 mm)
Long and narrow, becoming narrower towards the posterior end. First two pairs of legs long and stout and held out in front of the flat abdomen. Abdomen green.
Habit: Sedentary foliage hunters, well camouflaged.

137. *Thomisus sp.* 1 (maroon) (Size: 6-8 mm)
Triangular and much wider posteriorly and truncated. First two pairs of legs of legs longer and stouter than the other two pairs. Maroon with a few decorations on the abdomen. Lateral eyes on conical protuberances if noticed carefully.
Habit: Sedentary foliage hunters, well camouflaged posture crab like.

138. *Thomisus sp*. 2 (cream) (Size: 6-8 mm)
Triangular and much wider posteriorly and truncated. First two pairs of legs of legs longer and stouter than the other two pairs. Cream with a few black decorations on the abdomen. Lateral eyes on conical protuberances if noticed carefully.
Habit: Sedentary foliage hunters, well camouflaged posture crab like.

139. *Thomisus sp.* 3 (green) (Size: 6-8 mm)
Long and narrow and flat, cigar shaped. Resembles Oxytate virens.
Habit: Sedentary foliage hunters, well camouflaged, posture crab like, first two pairs held out in front.

140. *Thomisus sp*. 4 (brown) (Size: 6-8 mm)
Triangular and much wider posteriorly and truncated. First two pairs of legs of legs longer and stouter than the other two pairs. Brown with a few dark brown decorations on the abdomen. Lateral eyes on conical protuberances if noticed carefully.
Habit: Sedentary foliage hunters, well camouflaged, posture crab like.

141. *Thomisus sp*. 5 (yellow) (Size: 8-9 mm)
Triangular and much wider posteriorly and truncated. First two pairs of legs of legs longer and stouter than the other two pairs. Yellow with a few black decorations on the abdomen. Lateral eyes on conical protuberances if noticed carefully.
Habit: Sedentary foliage hunters, well camouflaged, posture crab like.

142. *Tmarus sp*. (Size: 6-7 mm)
Long and conical and the posterior becomes broader and truncates upwards. Cream, brown and dark brown patches on the dorsal side. Lateral eyes not on conical protuberances.
Habit: Well camouflaged because it usually sits on a twig with its first two pairs of enlarged legs outstretched in front.

FAMILY ULOBORIDAE
143. *Hyptiotes sp.* (brown) (Size: 4-6 mm)
Brown, globular and with two pairs of protuberances, overlapping strongly over the carapace. Spider sits with its first two pairs of longer legs outstretched in front, ventral side facing upwards. Cepahlothorax comparatively flat
Habit: The outstretched legs hold one end of the sector of a vertical orb web which it builds. The orb web sector takes a triangular shape and the web is very fine and hence difficult to spot.

144. *Miagrammopes sp*. (Size: 7-12 mm)
Long flat and thin, resembles a twig and sits ventral sides facing up with its first pair of really long legs and the second slightly smaller pair outstretched.
Habit: Single line web or two lines which form a loose triangle, the end of which is attached to the outstretched legs of the spider.

145. *Uloborus sp.* 1 (brown) (Size: 4-6 mm)
Broad and elliptical, and the last two segments in the legs become narrow and the first pair of legs longer than the rest.
Habit: Horizontal complete orb webs with a line of silk running across it through the hub and the spider sits on the lower side of the web on the hub, with its legs outstretched.

146. *Uloborus sp.* 1 (brown, commensal) (Size: 4-6 mm)
Broad and elliptical, and the last two segments in the legs become narrow and the first pair of legs longer than the rest.
Habit: Horizontal complete orb webs with a line of silk running across it through the hub and the spider sits on the lower side of the web on the hub, with its legs outstretched. Found to be a commensal on webs of Theridids and uses the web strands of the host to form part of its web.

147. *Uloborus sp.* 2 (cream) (Size: 6-7 mm)
Cream and elliptical, and the last two segments in the legs become narrow and the first pair of legs longer than the rest. Cephalothorax black.
Habit: Horizontal complete orb webs with a line of silk running across it through the hub and the spider sits on the lower side of the web on the hub, with its legs outstretched.

148. *Uloborus sp*. 2 (cream, commensal) (Size: 6-7 mm)
Cream and elliptical, and the last two segments in the legs become narrow and the first pair of legs longer than the rest. Cephalothorax black.
Habit: Horizontal complete orb webs with a line of silk running across it through the hub and the spider sits on the lower side of the web on the hub, with its legs outstretched. Found to be a commensal on the webs of *Psechrus torvus* and uses the web strands of the host to form part of its web.

149. *Uloborus sp.* 3 (orange) (Size: 4-6 mm)
Bright orange with cream markings and elliptical, and the last two segments in the legs become narrow and the first pair of legs longer than the rest. Cephalothorax black.
Habit: Horizontal complete orb webs with a line of silk running across it through the hub and the spider sits on the lower side of the web on the hub, with its legs outstretched.

150. *Uloborus sp.* 3 (orange, commensal) (Size: 4-6 mm)
Cream and elliptical, and the last two segments in the legs become narrow and the first pair of legs longer than the rest. Cephalothorax black.
Habit: Horizontal complete orb webs with a line of silk running across it through the hub and the spider sits on the lower side of the web on the hub, with its legs outstretched. Found to be a commensal on the webs of *Psechrus torvus* and uses the web strands of the host to form part of its web. Males are a little smaller and have a prominent black and elevated cephalic region.

151. *Uloborus sp.* 4 (grey) (Size: 6-7 mm)
Grey and elliptical, and the last two segments in the legs become narrow and the first pair of legs longer than the rest. Cephalothorax black.
Habit: Horizontal complete orb webs with a line of silk running across it through the hub and the spider sits on the lower side of the web on the hub, with its legs outstretched.

152. *Uloborus sp.* 5 (yellow) (Size: 6-7 mm)
Bright yellow and elliptical, and the last two segments in the legs become narrow and the first pair of legs longer than the rest. Cephalothorax black.
Habit: Horizontal complete orb webs with a line of silk running across it through the hub and the spider sits on the lower side of the web on the hub, with its legs outstretched.

153. *Uloborus sp.* 6 (tree bark) (Size: 5-6 mm)
Resembles the genus *Philoponella*. Strongly overlaps over the carapace, sits ventral side facing upwards. The abdomen is broad and cone shaped, forming a blunt tip at the posterior end. Sits with its legs close to its abdomen and its first pair of longer legs are placed over half of the ventral portion.
Habit: Horizontal orb web always against the base of a tree trunk a few centimeters above ground level. Spider sits away from the orb and is very difficult to spot, because the colour merges with the colour of the tree trunk and sometimes pieces of debris cover it up.

154. *Uloborus sp*. 7 (Size: 3-4 mm)
Posterior end is segmented to form three notches. Black with a brown patch on it.
Habit: Incomplete horizontal orb web.

155. *Zosis geniculatus* (Size: 5-7 mm)
Brown, cone shaped and ventral side facing up. There are blunt protrusions on the dorsal side. First pair of very long legs which has black horizontal stripes. The first two pairs of legs are outstretched and are held forward, the first pair touching each other. On the first pair of legs there are thick

tufts of hair on the second segment from the tip of the legs, giving it the common name feather legged spiders.
Habit: Triangle shaped horizontal orb web sometimes with a zig zag line of silk running across through the hub.

156. *Zosis geniculatus?* (yellow) (Size: 7-8 mm)
Yellow, cone shaped and ventral side facing up. There are blunt protrusions on the dorsal side. First pair of very long legs which has black horizontal stripes. The first two pairs of legs are outstretched and are held forward, the first pair touching each other. On the first pair of legs there are thick tufts of hair on the second segment from the tip of the legs, giving it the common name feather legged spiders.
Habit: Triangle shaped horizontal orb web sometimes with a zigzag line of silk running across through the hub.

OPPORTUNISTICALLY RECORDED SPECIES

FAMILY ARANEIDAE
157. Cyrtarachne raniceps (Size: 9-10 mm length, 8-8.5 mm abdomen width, and 7.5 mm abdomen length)
Abdomen is bright yellow, longer than wide and almost triangular, large, smooth and strongly overlaps with the cephalothorax. There are two egg shaped patches which are brown towards the middle of the abdomen. The cephalothorax and legs are yellowish brown. The legs are held close to the body when at rest.
Habit: Nocturnal, no traces of web in the day, sits on a leaf.

158. Cyrtarachne sp. (schmidi?) (Size: total length 6-7 mm, abdomen 8-8.5 mm wide and 4-5 mm long)
Abdomen wider than long, overall yellow, towards the posterior side green and cream interspersed. Anterior part of abdomen maroon boomerang shaped band. Above the band, bright yellow along the margin of the abdomen. In the middle two pairs of conspicuous sigilla forming a square pattern. At the widest part the tips are slightly pointed.
Cephalothorax is green and the legs are overall green and yellow. Towards the end red and brown, all the legs are kept close to the abdomen.
Habit: No trace of any web, nocturnal sighting.

*159. Gea subarmata (= Gea corbetti) (*Size: 5.8-6 mm)
Abdomen slightly overlaps on the cephalothorax. Anterior side has one pair of prominent horns or humps which are black. There are faint black and brown zigzag patterns and dots all along the abdomen and is clothed with black sparse hair. Ventral side has a median light brown broad band guarded by three pairs of silver roundish patches, the last pair just above the spinnerets. Cephalothorax is orange with a prominent longitudinal groove.
Habit: Vertical orb just above ground level. Sits on the hub cephalothorax pointing downwards, posture like that of *Argiope*.

160. Pasilobus kotigeharus (Size: 7-8 mm length, 14-15mm abdomen width)
Cephalothorax and abdomen overall deep chocolate brown. The abdomen is at least twice as wide as long and slightly overlaps over the carapace. There are prominent numerous blunt tubercles. There is one pair of prominent horn like projections towards the middle of the abdomen. The abdomen also has large and distinct sigilla. The ventral side is also deep chocolate brown getting darker towards the spinnerets.
Habit: Nocturnal, reduced orb, few triangular strands with a faint orb structure.

161. Poltys sp. (Size: 12-13 mm)
Most prominent feature of this cryptic spider is the abdomen which is long, prominent and high anteriorly. During the day the legs are pressed closed to the body in a 'hunched' position on twigs or branches of shrubs and trees. The eyes (cephalic region) projects outwards. Overall it is brown to dark brown and very well camouflaged. A lateral view of the spider gives the impression that it is carrying something on its back.
Habit: This species is nocturnal and builds its vertical orb at night and bringing it down by day.

FAMILY THOMISIDAE (PHILODROMIDAE)
162. Tibellus sp. (Size: 6-7 mm)
Cryptic and well camouflaged the cephalothorax is flat and broad; abdomen is long, flat, thin and almost four times longer than wide. The whole spider is green. When at rest the first two pairs of legs are kept outstretched close to the body in front and the last two pairs outstretched behind.
Habit: Lie outstretched under the leaves of shrubs and move sideways like a crab when disturbed.

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